DOCUMENT RESUME

ED 401 113 SE 059 094

AUTHOR	Rainey, Larry; Mitrook, Kim
TITLE	The University of Alabama's Integrated Science Program.
INSTITUTION	Alabama Univ., Tuscaloosa. Center for Communication and Educational Technology.
PUB DATE	10 Sep 96
NOTE	135p.
AVAILABLE FROM	University of Alabama, Center for Communication and Educational Technology, P.O. Box 870167, Tuscaloosa, AL 35487; phone: 800-477-8151.
PUB TYPE	Guides - Classroom Use - Teaching Guides (For Teacher) (052) -- Guides - Non-Classroom Use (055) -- Audiovisual/Non-Print Materials (100)
EDRS PRICE	MF01/PC06 Plus Postage.
DESCRIPTORS	Chemistry; Earth Science; Educational Innovation; Electronic Mail; Formative Evaluation; Inquiry; *Interdisciplinary Approach; *Middle Schools; Physics; *Professional Development; Science Activities; *Science Curriculum; *Scientific Literacy; Standards; Student Attitudes; Summative Evaluation; Telecommunications; *Telecourses
IDENTIFIERS	Alabama

ABSTRACT

This program, supported by the Center for Communication and Educational Technology at the University of Alabama, incorporates the perspectives of biology, earth/space science, chemistry, and physics into an innovative science curriculum for the middle grades. Students are engaged for 20 minutes 3 times a week by an on-air instructor who is doing fieldwork, talking with special guests, or using technology to introduce science concepts. These telecasts are delivered via satellite and can be seen on public television networks. Correlated curriculum materials are used by classroom teachers to conduct demonstrations, and lead their classes in hands-on activities and discussions that extend the understanding of the concepts presented in the telecasts. Prior to using this curriculum, teachers participate in a week of training and become part of an electronic mail network that allows them to share information, evaluations, and questions with one another and with the project staff. Information sheets, program description information, and a videotape accompany the student handbook. Contains 24 references. (DDR)

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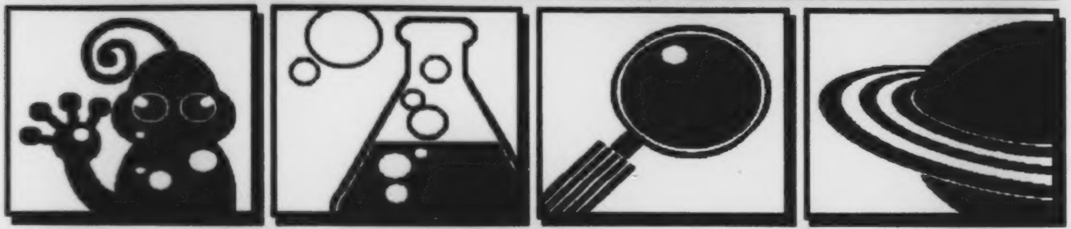
INTEGRATED



SCIENCE

The University of Alabama

- ✓ Telecasts
- ✓ Hands-On Activities
- ✓ Student Handbooks
- ✓ Teacher Manuals
- ✓ Summative and Formative Assessments
- ✓ Electronic Mail w/1400 Science Educators
- ✓ Summer Training Workshop
- ✓ Innovative Middle School Science Curriculum
- ✓ Compatible with New National Standards in Science

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INTEGRATED SCIENCE

PROGRAM DESCRIPTION

Introduction

Responding to a widespread concern over the prevalence of scientific illiteracy, The University of Alabama's Center for Communication and Educational Technology (CCET— a nonprofit organization) created a new middle school science curriculum. Integrated Science is a multi-year program based on the work and recommendations of the American Association for the Advancement of Science (AAAS) as outlined in Project 2061, and the National Science Teachers Association (NSTA) publication "Scope, Sequence and Coordination in Secondary School Science." This research is also shaping the new national science standards and state courses of study. School systems in several states are adopting Integrated Science in conjunction with or to replace textbooks in order to meet the new standards.

Integrated Science introduced its first course offering, Integrated Science 7 (IS7), during the 1991-92 school year. It has since added Integrated Science 8 (IS8) and Integrated Science 6 (IS6). **In six years the project has grown over 1,300% and currently involves more than 150,000 middle school students in 13 states and Quebec, Canada.**

Program Design

Students examine a small group of topics from the perspectives of biology, chemistry, physics, and earth/space science. Because the basic sciences are introduced simultaneously, students can see how they fit together in a larger body of knowledge. The Integrated Science curriculum is designed as a three-year continuum. Each block at each grade level has a single, integrating concept organized around a central theme. All of the blocks offer multiple cross-curricular opportunities.

Course Content

Integrated Science emphasizes the mastery of key concepts and the development of problem-solving skills rather than rote memorization. We have adopted the following NSTA recommendations on instructional strategies:

- Appropriate for heterogeneous groups.
- Constructivist learning, building on student perceptions.
- Heavy emphasis on hands-on activities dealing with familiar phenomena.
- Student-centered lessons.
- Increased parental support and family involvement in science activities.

Program Goals

- Rekindle student interest in science.
- Keep students enrolled in science for more years.
- Produce more scientifically literate adults.

To accomplish these goals, our **principal strategy** focuses on training teachers to master the Integrated Science approach. CCET provides support for teachers and their students through inservice, our electronic network, and state-of-the-art curriculum materials. Integrated Science provides students with many opportunities to develop forecasting, planning, decision-making, and communication skills in addition to a well-rounded science knowledge base.

Curriculum Resources Include:

- **Weekly Telecasts**
- **Teacher Manuals w/ Classroom Activities**
- **Student Handbooks**
- **Teacher Professional Development (summer training and e-mail support)**

INTEGRATED SCIENCE

CURRICULUM RESOURCES

TELECASTS

A lead instructor, along with visiting scientists, teachers, and students, introduces major science topics and concepts in three weekly 20 minute telecasts. Field video packages, graphics, animation and other specialized television techniques known to engage student interest are used along with an outstanding variety of resources, from the camera-fitted microscope to laser disc technology. This variety provides students with experiences that are beyond the scope of even the best-equipped classrooms. The telecasts introduce the core information of the science concepts from the "real world" that students relate to best. The field packages transport students to many different and exciting places where they see these concepts used in everyday life, as well as gain exposure to many careers related to science and technology. **The telecasts are recorded by the teacher from a satellite or participating local public television station and are used in the classroom two weeks later.**

Please Note: If Integrated Science is not shown on your local public television network, you will need to view the telecasts via satellite or purchase tapes.

Many parents ask why Integrated Science students "watch television." Teachers using the program say that telecasts are key because...

- Telecasts are able to introduce the core information for each concept by relating it to everyday life. Middle school teachers who may feel uncomfortable using an integrated approach do extremely well in partnership with the IS on-air instructor.
- Telecast field packages take students to many different and exciting places, stimulating their curiosity. These packages teach the science concepts from the "real world" that students relate to best.
- Having the telecasts as part of the curriculum resources is important for visual learners, students with low reading skills, ESL students and many more.
- Telecasts are continually updated. They are reviewed and revised by university experts in curriculum development and television production.
- All students in a school are exposed to the major concepts in the same way. Because the telecast is recorded, there is always a document available of what's being taught. Parents can also review the material.
- Students are exposed to many careers related to science and are introduced to many science and technology experts through the telecasts.
- As new technologies become available, they become integrated into the production of the telecasts.
- During the telecasts, teachers are able to monitor students for comprehension, and through discussion, they can promote critical thinking skills.

INTEGRATED SCIENCE

CURRICULUM RESOURCES

CLASSROOM ACTIVITIES

Students begin by observing familiar phenomena with emphasis on hands-on activities. These activities help students develop critical thinking skills and give them a better understanding of how science relates to real world problems. Coordinated lesson plans and the student handbooks offer classroom teachers a selection of brief demonstrations or mini-activities related to each telecast as well as suggestions for discussion topics. Lesson plans also include a selection of hands-on activities to be used in cooperative learning groups which require a full class period. Teachers are urged to use hands-on activities at least twice a week.

Teacher Manual

The Integrated Science Teacher Manual will provide you with daily lesson plans organized by week. These plans will include the following:

- Background information
- Hands-on activities handouts and lab sheets
- A materials list for activities
- Homework, activity, and block assessments
- Block objectives
- Illustrations and diagrams of activities

Teachers receive four volumes of the Teacher Manual that correspond with four volumes of Student Handbooks.

Why hands-on activities are key to the IS program:

- Activities are a student-centered approach that stimulates interest and improves students' attitudes toward science.
- Activities reinforce concepts introduced in the telecasts.
- Activities are especially valuable for the large group of students who learn best by doing. Integrated Science helps teachers support all learning styles.
- In doing hands-on activities, students acquire science process skills.
- Experiential learning promotes critical thinking.
- Activities teach life skills such as measuring and quantifying.
- Being part of a cooperative learning team during activities prepares students for future team responsibilities.
- Teachers can use activities as the basis for performance-based assessments.

CURRICULUM RESOURCES

STUDENT HANDBOOKS

An innovative student handbook for each block provides additional background material and homework assignments which help develop higher order thinking skills and relate science to everyday events. Each lesson has a corresponding reading section, and the chapter ends with a homework activity that summarizes the week. The handbook uses areas of known student interest along with interesting graphics to reinforce the scientific concepts presented.

Handbooks are key to the IS program because...

- Students will find all the important aspects of the core science content in the handbooks.
- The reading assignments reinforce the concepts introduced in the telecasts.
- The books are designed to be user friendly for students (non-intimidating) and visually appealing.
- The book format is inexpensive and, as a nonprofit entity, The University of Alabama is able to price the books very reasonably.
- The handbook contains hands-on experiments using common everyday products which students can try at home. These activities provide an opportunity for sibling, parent and primary caregiver involvement.

Purchasing Student Handbooks:

- Each of the four blocks of study has its own handbook. Handbooks are updated on a three-year rotation schedule. Desktop technology and a soft cover format support revision efforts so each printing offers the most current information available.
- New teachers receive a classroom set of 30 handbooks for each volume.
- CCET's policy for new teachers is to replace handbooks for one year (including the classroom sets) if there has been a significant change (e.g. a new topic is introduced.) When minor corrections are made, the handbook is not replaced.
- If a school requests copyright permission to make photocopies of the books for their students, they must agree to reproduce the book in its entirety.
- If your state allows a certain percentage of textbook dollars to be allocated by local choice, those moneys can be used.
- If it does not, your system policy may allow you to ask students to purchase a set of books ($15.95 per set or $13.00 per set when quantities of 100 or more are purchased and sent to one address).
- Local businesses or civic clubs may be willing to help buy student handbooks as a way of supporting science education.
- **Books last.** Books only remain "in circulation" for 6-9 weeks and we have had no complaints about durability, even from schools who have used their books for 3 to 4 years.

INTEGRATED SCIENCE

CURRICULUM RESOURCES

TEACHER PROFESSIONAL DEVELOPMENT

Supporting teachers is a fundamental part of the Integrated Science program design. CCET provides a highly supportive and personal approach to teacher training. Through summer workshops and electronic mail, teachers are given all the resources needed to master and implement new content and new teaching methods. This model is unique in distance education because it trains and empowers the local classroom teachers, rather than replacing them.

Summer Inservice

New teachers attend a four-day workshop while second and third year teachers attend a one-day workshop in the summer. Experienced teacher trainers currently teaching Integrated Science lead these sessions and offer tremendous insight to first-year teachers.

Training is provided in the following areas:

Cooperative Learning
Classroom Management
Evaluation and Alternative Assessments
Curricular Resources
Model Classrooms
Hands-On Activities
Electronic Computer Mail Training
Nurturing Higher Order Thinking Skills
Cross-Curricular Opportunities
Tournaments
Using Video Interactively
Class Projects
Student Incentives
Alternative Activities
New State Science Curriculum Changes
Absenteeism
and other trouble-shooting techniques

Continuing Education Units

The University of Alabama's College of Continuing Studies offers credit through continuing education units (CEUs) for participation in the summer workshop. The project allows teachers to master a new curriculum approach while continuing in their regular classroom role. Those participating in the project report enormous personal growth and increased enthusiasm for teaching.

CURRICULUM RESOURCES

On-line Advice

The flow of information between teachers and the University does not stop after the workshop. In order to participate in the program, each school system must provide their teachers with "daily access" to a computer, modem, and phone line at their schools. CCET provides the teachers with the electronic mail software and a toll-free phone number at the University. The e-mail network connects participating teachers with CCET staff and each other. This readily-available communication link opens up new possibilities for teachers.

What E-Mail Can Do For You

- Provides teachers the opportunity to ask questions and/or give their input about all aspects of the program.
- Allows CCET to offer continuous support and send supplementary materials or updates (e.g. telecast descriptions, telecast assessment sheets, answer science questions, block assessments).
- Gives CCET frequent feedback and evaluation of all aspects of the program by encouraging teacher input.
- Provides contact with other teachers for ideas, materials, and advice.
- Allows teachers to get topic-specific information from bulletin boards.
- Allows teachers to cut, copy, and paste materials from e-mail by bringing the information into a word processing program.
- Provides an easy way to send in winners' names for competitions.
- Allows participation in data collection for classroom projects.
- Supports interaction among students in different schools.
- Promotes professional growth.
- Allows student input.
- Allows students to become "computer pals" with other IS students.
- Promotes interest in computers and technology.

ADVICE ON-LINE

Please Note: This is an actual example of how teachers use E-mail to collaborate on effective teaching techniques for Integrated Science.

ADVICE EXAMPLES

Author: lynne jennings at science
Date: 12/23/95 12:46 PM
Subject: Special Education

--------------------Message Contents--------------------

I need some information on how special education students are doing in the IS classes. For some of my students I am having to make extensive modifications which I did not expect to have to make. Please let me know if any of you are also having problems with modifications for special ed.

Author: David Scott at Science
Date: 1/21/95 4:23 PM
Subject: Special Education

--------------------Message Contents--------------------

We all have special ed. students in our Science classes in our school. I sit in conference after conference, and I am the only one with good news about achievement and progress. The parents keep asking what I am doing different in science compared with the other subjects. Our special education teacher says that our integrated science classes are the only classes where she does not have to completely re-teach the material to "her" kids. 2 suggestions I might have.

We have very selective placement of these kids into cooperative groups. A group with a few kids who like to help. When modifying their program (if necessary) I eliminate the vocabulary and try to test for basic concepts learned through the hands-on activities. I don't know if this will help, but Good Luck!

Author: Rita Wright at Science
Date: 1/23/95 11:08 AM
Subject: Re: Special Education

--------------------Message Contents--------------------

I have LOTS of special ed students in my classes. I also modify but usually the modifications are not difficult for me. Some of the things I do are: 1) give all special education teachers copy of my lesson plans (in two week blocks) this way they know what we are doing and can help the special ed students keep up 2) give extra time and accept late work form SPE students 3) my grade book program allows me to exempt students from any assignment so if I (or the SPE teacher) feel an assignment is too difficult, we don't count it. Hope this helps.

Author: Anna Cook at Science
Date: 1/24/95 4:57 AM
Subject: Re: Special Education

- - - - - - - - - - - - - - - - - - - -Message Contents- - - - - - - - - - - - - - - - - - - -

My special education students, at first, were not doing very well. I contribute this to never doing this type of science. However, since the first nine weeks these students have greatly improved. The only problem I've had is with the research paper since then. My special education teacher has helped me a lot in developing notes off the telecasts to assist not just special education students, but all students. I also have a notebook evaluation at the end of each nine weeks, which helps the special education students become organized and therefore, the science is easier for them. --Anna Cook

Author: Brad Holley at science
Date: 1/23/95 9:50 PM
Subject: Sp. Ed. Students

--------------------------------Message Contents----------------------------------

The only modifications I have to make is to make extra copies available for the Sp. Ed. teachers of the homework assignments, video descriptions, telecast assessment sheets and any other assessments tools I choose to use. The Sp.Ed. teachers use the materials to help the students on a more one-to-one basis.

In IS class, however, the Sp. Ed. students usually do quite well. They are helped tremendously by their group members (Everyone wants to be on a Super Team!). The speed student generally attains a lot of IP's and are easily motivated to get as many ac possible so their self esteem soars when they realize how important they are to the team.

Talk with your Sp. Ed. teachers. They should be more than glad to help those students with the more difficult tasks they encounter in the IS (or any other class!) program. I also send the students to the teachers for assessments such as tests and quizzes so that they can help them with the reading aspects.

Hope this helps or in some way answers your questions. This has helped me with all Sp. Ed. students that fall under "Inclusion."

HELPFUL HINTS EXAMPLES

Author: Jana Hill at Science
Date: 1/29/96 9:28 PM
Subject: Web Sites

---Message Contents---

This is for those of you who have access to the World Wide Web.I found 2 great spots for your students to visit for the Travel the Universe Activity or just and enhancement to the unit. Here they are remember to type them in exactly as shown.

- http://stardust.jpl.nasa.gov/gov/galileo

This sight has pictures of all the planets and by double clicking on the photo you bring up even more info and pictures.

- www.jpl.nasa.gov/galileo

This address will keep you up to date on the Galileo Space Probe along with other stuff like photos of the Comet Shoemeker-Levy 9 collision with Jupiter. I am having my students use at least one Web site (probably the Stardust) as part of their research for the Travel the Universe activity.
Let me know what you think.

Jana Hill

Author: Dave Roycroft at Science
Date: 0/03/96 4:17 PM
Subject: Web Sites

---Message Contents---

Many people have been asking for good science and education web sites. What follows is a list of URLs (universal resource locators) that I have found to be pretty good.
http://www.enews.com/magazines/discover/webtur.html
http://www.yahoo.com/Education/Math_and_Science_Education/
http://www.nceet.snre.umich.edu/edlinks.html
http://www.mts.net%7Ejgreenco/jerdeb.html
http://www.skypub.com/
http://www.cnn.com/CNN/Programs/Science/index.html
http://www-hpcc.astro.washington.edu/scied/science.html
http://www.exploratorium.edu/
http://sin.fi.edu/tfi/hotlists/kid-sci.html
Most of these sites point to many other sites in science and education.
Integrated Sciences url is: http://www.sa.ua.edu/sa/ccet/is.htm

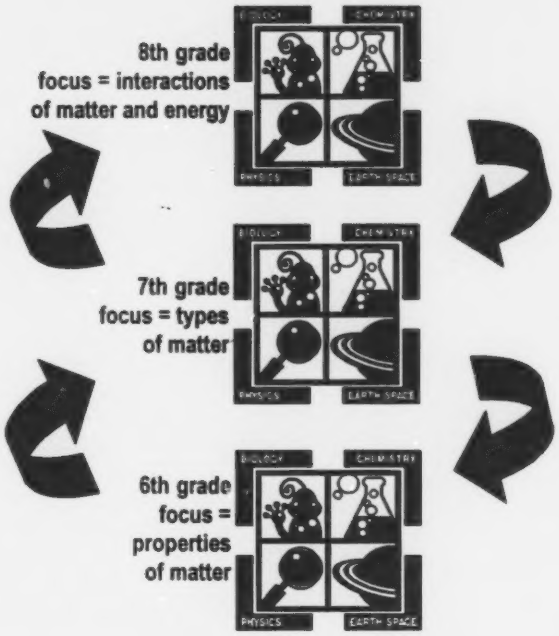
INTEGRATED SCIENCE

CURRICULUM DESIGN

Three Year Spiraling Curriculum

The Integrated Science curriculum is a spiraling sequence of blocks of material, allowing topics introduced in one grade to be built upon in successive grades.

For example, sixth grade introduces the concept that everything is composed of atoms and briefly discusses the components of an atom. In seventh grade, this information is reviewed and the following added: atoms make up elements and each element is a different atom. The Periodic Table and the properties of elements are introduced. In the eighth grade, students approach the topic of atoms by looking at their reactivity — how different atoms interact to form molecules and the energy required or produced by chemical reactions. The Integrated Science curriculum provides a base of knowledge for students to work on and build upon each year. By spiraling back to major scientific concepts over the three year course of study, students enter high school with a firm understanding of what science is and how it relates to their world.


8th grade focus = interactions of matter and energy
7th grade focus = types of matter
6th grade focus = properties of matter
BIOLOGY
CHEMISTRY
PHYSICS
EARTH SPACE

ESSENTIAL ELEMENTS OF THE INTEGRATED SCIENCE MODEL

- All science disciplines are taught every year.
- Science disciplines are integrated/coordinated around a set of topics.
- Less is more ... places more emphasis on fewer concepts.
- Introduces the concrete before the abstract.
- Uses spaced learning: introduces an idea and then spirals back to it again and again.
- Focuses on hands-on activities because they bring enjoyment, more involvement and increased comprehension.
- Recommends heterogeneous groupings in classes.

IMPORTANT CHARACTERISTICS OF INTEGRATED SCIENCE

- Uses daily life applications in the curriculum.
- Uses technology to enrich the curriculum.
- Includes issues with a societal application.
- Uses cooperative learning groups.
- Uses alternative and performance-based assessment strategies.
- Integrates math and science concepts.
- Recommends cross-curricular connections among science and other subject areas.

THREE YEAR OVERVIEW OF INTEGRATED SCIENCE

	IS6	IS7	IS8
BLOCK 1	CLUES	PATTERNS	WAVES
Integrating Concept: The Universe has regular and predictable patterns.	**Theme:** Observations provide clues. **Topics:** senses/perception neurons/archeology paleontology digestive system symmetry scientific inquiry	**Theme:** Form and function are related. **Topics:** scientific investigation classification circles/spheres cylinders/spirals triangles/fractals circul. & respir. systems	**Theme:** Waves have measurable properties in a repeating pattern. **Topics:** wave similarities/differences/ behavior water waves seismic waves sound waves electromagnetic waves sensory organs: ears & eyes
BLOCK II	MACHINES	FORCES	ENERGY
Integrating Concept: Matter and Energy can change forms.	**Theme:** Work requires energy. **Topics:** properties of matter work/energy forces simple machines skeletal system muscular system	**Theme:** Forces act on matter. **Topics:** gravity/friction types of matter Periodic Table electricity magnetism nervous system	**Theme:** Energy holds matter together. **Topics:** forms of energy energy present in matter chemical reactions energy in living systems alternative energy sources
BLOCK III	CYCLES	CHANGE	STAGES
Integrating Concept: Change is the universal constant.	**Theme:** Change can operate in cycles. **Topics:** **Universe** seasons tides **Earth** weather geographic cycles **Organisms** cells life cycle	**Theme:** Change is ongoing. **Topics:** **Universe** solar system/planets asteroids/comets **Earth** Earth's structure crustal movement weathering/erosion **Organisms** cell division/heredity human life cycle	**Theme:** Some change has no timelines. **Topics:** **Universe** models of the universe galaxies/stars/uncommon objects **Earth** geologic time radiometric development rock cycle **Organisms** embryonic development evolution and extinction
BLOCK IV	ENVIRONMENT	ENVIRONMENT	ENVIRONMENT
Integrating Concept: Environments balance the living and nonliving.	**Theme:** The biosphere supports life. **Topics:** biosphere biomes/climate adaptations relationships	**Theme:** Ecosystems are both fragile and complex. **Topics:** soil/water food chains/webs niche/habitat succession	**Theme:** Human activities impact the environment. **Topics:** population growth environmental degradation global concerns environmental economics

INTEGRATED SCIENCE

PROCESS SKILLS OBJECTIVES

At the completion of IS6, a student should be able to:

- make qualitative and quantitative observations.
- observe and describe changes in phenomena.
- use instruments to make and record metric measurements.
- formulate a scientific question based on observations.
- recognize what makes up a scientific inquiry.
- recognize that experiments have variables and controls.

At the completion of IS7, a student should be able to:

- construct a hypothesis and test its prediction in an experiment.
- identify independent and dependent variables.
- recognize that scientific inquiry involves more than a series of sequential steps.
- use appropriate strategies to conduct an experiment.
- collect, organize, and process information.
- write a conclusion that evaluates a hypothesis in terms of data obtained.
- as a member of a team, design an experiment, given a hypothesis.

At the completion of IS8, a student should be able to:

- distinguish between observations and inferences.
- identify observations that support an inference.
- make inferences and predictions from data.
- design an experiment, given a hypothesis.
- recognize the value of models in science.
- use a model to summarize information.

INTEGRATED SCIENCE

PROGRAM HISTORY

Over the past several decades, there has been a continuing call for reform of science education for Americans of every economic group. The University of Alabama, located in Tuscaloosa, Alabama, responded to this widespread concern over scientific literacy by initiating the recommendations of Dr. Larry Rainey. A professor of education at The University of Alabama and a veteran middle school science teacher, Dr. Rainey proposed the development of a middle school science curriculum that would combine the forces of higher education, public schools, public television and private enterprise. This curriculum would synthesize an integrated course of study with accessible technology in order to empower teachers to motivate students of all levels of economic and scholastic ability. Under the leadership of Dr. Rainey, the staff of The University of Alabama's Center for Communication and Educational Technology (CCET) developed this multi-year instructional program called Integrated Science. This program was based on the recommendations of the National Science Teachers Association's (NSTA) "Project on Scope, Sequence and Coordination for Secondary School Science" and the American Association for the Advancement of Science (AAAS) in "Project 2061" and their publication "Benchmarks for Scientific Literacy." Subsequently, the National Research Council released a new set of standards for science education. The CCET staff completed a correlation between the Integrated Science curriculum and those standards to ensure that the program met all requirements for scientific literacy.

> ***This curriculum would synthesize an integrated course of study with accessible technology in order to empower teachers to motivate students of all levels of economic and scholastic ability.***

The educational initiative began in the Spring of 1991 with CCET receiving funding for one year of development. This financial support was provided by Alabama Power Company Foundation, Alabama Public Television, AmSouth Bancorporation, IBM Corporation, The University of Alabama, and the Alabama State Department of Education (granting pilot status and approving the use of Eisenhower Title II funds.) This funding made it possible for the CCET staff to start inservice training on the campus of The University of Alabama, with a total of 97 teachers. The fall semester started as a pilot program of 7th grade Integrated Science, which involved 30 minute, live broadcasts on Alabama Public Television airing five days a week. Dr. Rainey was the on-air instructor. Student handbooks, teacher manuals and assessments were developed throughout the school year to correlate with the televised lessons.

The initial mission of the program was to serve teachers and students within the state of Alabama. However, news of Integrated Science spread quickly to adjacent states, and with increasing access to technology, enrollment for the

1992-93 school year grew to include 260 teachers participating in the program, many from Mississippi and Florida. A partnership was then formed with Mississippi Educational Television (METV).

During the first year of the project, teacher and student feedback was gathered on a regular basis. In response to the feedback, Integrated Science changed its format from live broadcasts to prerecorded telecasts and an 8th grade course was added to the curriculum at the beginning of the second year. A partnership was formed with the Satellite Educational Resources Consortium (SERC). SERC is the distance learning network supported by PBS. They distributed Integrated Science for 7th and 8th grade to ten states and also provided funding for development. The South Eastern Regional Vision for Education (SERVE), a federally-funded regional educational laboratory, conducted studies including site visits, surveys, and interviews with teachers and students. Integrated Science continued to receive funding from its corporate sponsors in addition to a grant from the Alabama Commission on Higher Education (ACHE). The program also received the Grand Gold Medal award by The Council for the Advancement and Support of Education (CASE) as well as 2nd place in the Academy Awards for distance learning at the TELECON conference.

> ***The program also received the Grand Gold Medal award by The Council for the Advancement and Support of Education (CASE) as well as 2nd place in the Academy Awards for distance learning at the TELECON conference.***

In 1993, a 6th grade course was added to the curriculum and enrollment grew to 720 teachers. Integrated Science was given the opportunity to do a pilot program for teachers in Quebec, Canada in conjunction with Radio Quebec. Financial support continued from corporate sponsors and the Alabama State Board of Education commended the Integrated Science program for its "successful approach to education reform, particularly to science education." In the summer of 1994, summer inservice expanded to include training sites in Tampa, Florida at the University of South Florida, and at Houick Elementary School in Houick, Quebec, in addition to several weeks of training in Tuscaloosa, Alabama. Enrollment again grew to 1,049 teachers for the 1994-95 school year. In 1995, summer inservice was held in Tampa and West Palm Beach, Florida. A partnership was formed with McGill University in Montreal and summer inservice training was held there in Quebec. Enrollment for the 1995-96 school year reached a total of 1,356 teachers. The staff of CCET enlisted the services of the Institute for Communication Research (ICR) to evaluate the performance of students using the program, and as a result, the project altered its resources to better fit the needs of the teachers and students. With support from public television stations and other distance learning partnerships, the program has continued to grow and reach over 150,000 middle school students in 6th, 7th, and 8th grades.

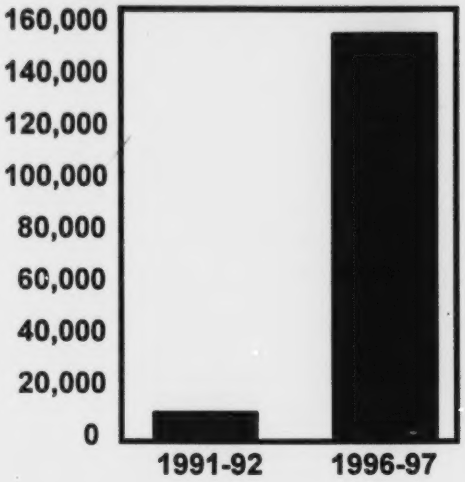
In 1996, Integrated Science has continued the ongoing effort of refining its product and expanding its partnerships. The 6th, 7th, and 8th grade production crews traveled to Mexico, the Amazon River Basin, and Costa Rica to tape footage for future telecasts. In the spring of 1996, a partnership was formed with Distance Learning Associates, Inc. to assist in the marketing of Integrated Science to national and international markets. The staff of CCET is currently working on a reorganization of its management structure in order to prepare for new market growth and program expansion.

INTEGRATED SCIENCE

ENROLLMENT DATA

In six years, the project has grown over 1,300% and currently involves more than 150,000 middle school students in 13 states and Quebec, Canada. As enrollment continues to grow, cooperative agreements with public television networks give teachers easy access to telecasts. Currently, Alabama Public Television, Mississippi Educational Television, North Carolina Public Television, Radio Quebec, and Palm Beach County's ITFS System carry IS programming. For satellite users, Georgia Public Television transmits the signal for Integrated Science to the nation.

STUDENT PARTICIPATION

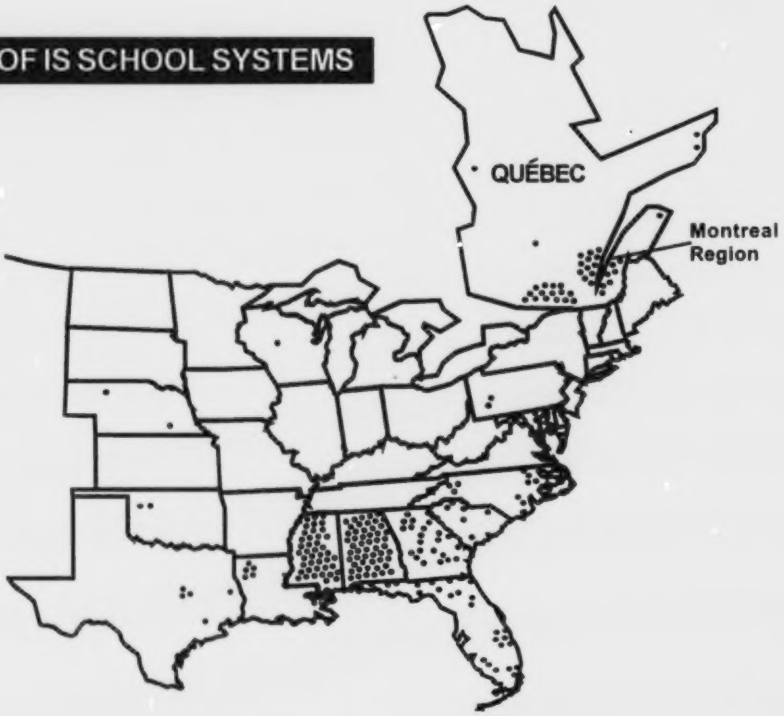


LOCATION OF IS SCHOOL SYSTEMS

The following locations have teachers enrolled in Integrated Science:

Alabama
Mississippi
South Carolina
Florida
Wisconsin
Oklahoma
Pennsylvania
Quebec, Canada

Georgia
Louisiana
North Carolina
Maryland
Texas
Nebraska



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INTEGRATED SCIENCE

SATELLITE AND PUBLIC TELEVISION SCHEDULES

SATELLITE USERS

GRADE LEVEL	DAY OF WEEK	TIME
IS6	Mondays	8:00 - 9:00 a.m. Eastern
IS7	Tuesdays	8:00 - 9:00 a.m. Eastern
IS8	Wednesdays	8:00 - 9:00 a.m. Eastern

Peach Start GPTV 1 / Telstar 401 Satellite / KU Band
Transponder 14 Lower / Horizontal Polarity
Frequency 12093 mhz / Audio 6.2 / 6.8 Mono

ALABAMA PUBLIC TELEVISION

GRADE LEVEL	DAY OF WEEK	TIME
IS6	Mondays	12:00 - 1:00 p.m. Central
IS7	Tuesdays	12:00 - 1:00 p.m. Central
IS8	Wednesdays	12:00 - 1:00 p.m. Central

MISSSISSIPPI EDUCATIONAL TELEVISION

GRADE LEVEL	DAY OF WEEK	TIME
IS6	Wednesdays	4:00 - 5:00 a.m. Central*
IS7	Thursdays	4:00 - 5:00 a.m. Central*
IS8	Fridays	4:00 - 5:00 a.m. Central*

This early morning schedule means that all Mississippi teachers will need to set the timers on their VCR's.

NORTH CAROLINA PUBLIC TELEVISION

GRADE LEVEL	DAY OF WEEK	TIME
IS6	Mondays	11:00-12:00 a.m. Eastern
IS7	Tuesdays	11:00-12:00 a.m. Eastern
IS8	Wednesdays	11:00-12:00 a.m. Eastern

RADIO QUEBEC

GRADE LEVEL	DAY OF WEEK	TIME
IS6	Tuesdays	1:00 - 2:00 p.m. Eastern
IS7	Wednesdays	1:00 - 2:00 p.m. Eastern
IS8	Thursdays	1:00 - 2:00 p.m. Eastern

FLORIDA
***Palm Beach Co. ITFS System**

GRADE LEVEL	DAY OF WEEK	TIME
IS6	Mondays (live)	8:00 - 9:00 a.m. Eastern
	Mondays (replay)	10:00-11:00 a.m. Eastern
IS7	Tuesdays (live)	8:00 - 9:00 a.m. Eastern
	Tuesdays (replay)	10:00-11:00 a.m. Eastern
IS8	Wednesdays (live)	8:00 - 9:00 a.m. Eastern
	Wednesdays (replay)	10:00-11:00 a.m. Eastern

WLRM MIAMI Channel 33

GRADE LEVEL	DAY OF WEEK	TIME
IS6	Mondays	8:00 - 9:00 a.m. Eastern
IS7	Tuesdays	8:00 - 9:00 a.m. Eastern
IS8	Wednesdays	8:00 - 9:00 a.m. Eastern

SCHOOLS IN ALL STATES NOT SPECIFICALLY LISTED ABOVE WILL NEED TO USE A SATELLITE DISH OR ORDER VIDEOS THROUGH THE UNIVERSITY OF ALABAMA/CCET. THE VIDEO COST IS $325.00 PER GRADE FOR THE ENTIRE YEAR. VIDEO FORMS WILL BE SENT SOON.

INTEGRATED SCIENCE

1996-1997 BROADCAST CALENDAR

Broadcast Date	6th Grade	7th Grade	8th Grade	Lesson Plan Date
None	Pre-Week 1	Pre-Week 1	Pre-Week 1	" " 8/19
None	Pre-Week 2	Pre-Week 2	Pre-Week 2	" " 8/26
Week of 8/19	Clues Week 1	Patterns Week 1	Waves Week 1	" " 9/02
" " 8/26	Clues Week 2	Patterns Week 2	Waves Week 2	" " 9/09
" " 9/02	Clues Week 3	Patterns Week 3	Waves Week 3	" " 9/16
" " 9/09	Clues Week 4	Patterns Week 4	Waves Week 4	" " 9/23
" " 9/16	Clues Week 5	Patterns Week 5	Waves Week 5	" " 9/30
" " 9/23	Clues Week 6	Patterns Week 6	Waves Week 6	" " 10/07
" " 9/30	Enrichment Week	Enrichment Week	Enrichment Week	" " 10/14
" " 10/07	Machines Week 1	Forces Week 1	Energy Week 1	" " 10/21
" " 10/14	Machines Week 2	Forces Week 2	Energy Week 2	" " 10/28
" " 10/21	Machines Week 3	Forces Week 3	Energy Week 3	" " 11/04
" " 10/28	Machines Week 4	Forces Week 4	Energy Week 4	" " 11/11
" " 11/04	Machines Week 5	Forces Week 5	Energy Week 5	" " 11/18
" " 11/11	Machines Week 6	Forces Week 6	Energy Week 6	" " 12/02
" " 11/18	Semester Review	Semester Review	Semester Review	" " 12/09
" " **11/25**	**NO BROADCAST**	**NO BROADCAST**	**NO BROADCAST**	
" " 12/02	Enrichment Week	Enrichment Week	Enrichment Week	" " 1/06
" " 12/09	Enrichment Week	Enrichment Week	Enrichment Week	" " 1/13
" " **12/16**	**NO BROADCAST**	**NO BROADCAST**	**NO BROADCAST**	
" " **12/23**	**NO BROADCAST**	**NO BROADCAST**	**NO BROADCAST**	
" " **12/30**	**NO BROADCAST**	**NO BROADCAST**	**NO BROADCAST**	
" " 1/06	Cycles Week 1	Change Week 1	Stages Week 1	" " 1/20
" " 1/13	Cycles Week 2	Change Week 2	Stages Week 2	" " 1/27
" " 1/20	Cycles Week 3	Change Week 3	Stages Week 3	" " 2/03
" " 1/27	Cycles Week 4	Change Week 4	Stages Week 4	" " 2/10
" " 2/03	Cycles Week 5	Change Week 5	Stages Week 5	" " 2/17
" " 2/10	Cycles Week 6	Change Week 6	Stages Week 6	" " 2/24
" " 2/17	Enrichment Week	Enrichment Week	Enrichment Week	" " 3/03
" " 2/24	Environment Week 1	Environment Week 1	Environment Week 1	" " 3/10
" " 3/03	Environment Week 2	Environment Week 2	Environment Week 2	" " 3/17
" " 3/10	Environment Week 3	Environment Week 3	Environment Week 3	" " 3/31
" " 3/17	Environment Week 4	Environment Week 4	Environment Week 4	" " 4/07
" " **3/24**	**NO BROADCAST**	**NO BROADCAST**	**NO BROADCAST**	
" " 3/31	Environment Week 5	Environment Week 5	Environment Week 5	" " 4/14
" " 4/07	Environment Week 6	Environment Week 6	Environment Week 6	" " 4/21
" " 4/14	Semester Review	Semester Review	Semester Review	" " 4/28
" " 4/21	Enrichment Week	Enrichment Week	Enrichment Week	" " 5/05
" " 4/28	Enrichment Week	Enrichment Week	Enrichment Week	" " 5/12
" " 5/05	Enrichment Week	Enrichment Week	Enrichment Week	" " 5/19

INTEGRATED SCIENCE

EQUIPMENT REQUIREMENTS

SPECIAL NOTE:

All classroom and computer equipment must be installed and operational by the beginning of the 1997-1998 school year.

CLASSROOM EQUIPMENT

Each Integrated Science teacher will need a television and video cassette recorder for exclusive use in the classroom.

ITEM	ESTIMATED COST
Television (a 25" or larger screen is recommended)	$275.00 - $350.00
VCR - VHS with remote control and weekly event programmability	$150.00 - $250.00

COMPUTER EQUIPMENT

Each Integrated Science teacher will need access to a computer, printer, modem, and dedicated telephone line for at least one class period per day. We recommend the Windows computer system.

MINIMUM REQUIREMENTS FOR EXISTING COMPUTER SYSTEMS	
Computer for user of cc:Mobile for Windows IBM PC or 100% compatible 80386 or better processor running at 33mHz or faster (a Pentium is recommended) 4 mb RAM minimum, 8 mb recommended hard disk drive with at least 10 mb free space 3.5 inch 1.44 mb (high density) floppy disk drive MS-DOS version 6.0 or higher MS Windows 3.1 or 3.11 or Windows 95 mouse VGA monitor	**Computer for user of cc:Mobile for Macintosh** Apple Macintosh LC or better System Software version 7.0 or higher hard disk drive with at least 10 mb free space 4 mb RAM minimum
ADDITIONAL EQUIPMENT REQUIRED FOR ALL USERS	
Printer - 24 pin dot matrix printer or ink jet printer, laser printer recommended **Modem - 14.4 baud or faster modem (US Robotics V .34 is recommended).** **Dedicated telephone line for the modem**	

Specifications and estimated costs for new computer systems and other computer equipment appear on the next page.

INTEGRATED SCIENCE

EQUIPMENT REQUIREMENTS

NEW COMPUTER SYSTEMS	ESTIMATED COST
Computer for user of cc:Mobile for Windows IBM PC or 100% compatible Pentium 4 mb RAM minimum, 8 mb recommended hard disk drive with at least 10 mb free space 3.5 inch 1.44 mb (high density) floppy disk drive MS-DOS version 6.0 or higher MS Windows 3.1 or 3.11 or Windows 95 mouse VGA monitor	**$1400.00 and up** **Recommended Computer to Purchase** (Dell, Gateway 2000, Compaq)
Computer for user of cc:Mobile for Macintosh Apple Macintosh LC or better System Software version 7.0 or higher hard disk drive with at least 10 mb free space 4 mb RAM minimum	$1700.00

ADDITIONAL COMPUTER EQUIPMENT	ESTIMATED COST
Printer - 24 pin dot matrix printer or ink jet printer (we recommend you consider a laser printer at a cost of $350.00 - $1500.00).	$125.00 - $400.00
Modem - 14.4 baud or faster modem (US Robotics V .34 is recommended).	$75.00 - $500.00
Dedicated telephone line, installed by your local telephone company.	Varies by telephone company (South Central Bell rate for teachers within Alabama is $10.44 per month)

HIGHLY RECOMMENDED EQUIPMENT

Multimedia capability (CD-ROM drive, stereo sound card, and speakers) will usually be included to the above systems but can be added for an additional $150.00 to $400.00.

QUESTIONS OR ASSISTANCE

Please contact Randy Palmer at 1-800-477-8151 for technical information and assistance.

INTEGRATED SCIENCE

EQUIPMENT PROVIDED

All first and second year Integrated Science teachers receive a science kit. Materials included in this kit are listed below:

Kit A - First and Second Year 6th Grade Teachers:

- 1 Digital balance
- 7 400 mL graduated beakers
- 7 100 mL graduated cylinders
- 7 Metric tape measures
- 7 Metric rulers
- 7 Solar cell calculators
- 7 Pocket field magnifiers
- 14 Ceramic magnets
- 1 Bottle of bromthymol blue
- 1 Vial of pH paper
- 1 Butterfly garden
- 1 Pulley kit
- 1 Pkg of 15 Owl pellets

Kit B - First and Second Year 7th Grade Teachers:

- 1 Digital balance
- 7 400 mL graduated beakers
- 7 100 mL graduated cylinders
- 7 Metric tape measures
- 7 Metric rulers
- 7 Solar cell calculators
- 7 Pocket field magnifiers
- 7 Magnetic compasses
- 7 Alligator clip leads
- 1 14 feet of magnetic wire
- 3 Pairs of bar magnets
- 1 Large display stop watch
- 14 Ceramic magnets

Kit C - First and Second Year 8th Grade Teachers:

- 1 Digital balance
- 7 400 mL graduated beakers
- 7 100 mL graduated cylinders
- 7 Metric tape measures
- 7 Metric rulers
- 7 Solar cell calculators
- 1 Bottle of calcium chloride
- 1 Bottle phenol red
- 1 Vial of pH paper
- 7 Tuning forks
- 1 Large display stop watch
- 1 Bottle of polysorb

INTEGRATED SCIENCE:
THE FINANCIAL ADVANTAGES

Decision-makers need to ask themselves some general questions when selecting resources. Is the curriculum designed to meet the latest national and state standards articulated for middle school science? Do the instructional materials use technology in a way that engages students' interest and supports the needs of students from every socio-economic and ability level? Will adequate training be offered to teachers? Are materials and/or funds available for hands-on activities? Will there be on-going support for teachers who implement change? Are evaluation and assessment materials, consistent with the curriculum objectives, available?

The answers to these questions have shaped the development of Integrated Science and contributed in large part to the success of the program. A combination of technologies (from computers to satellites) develop and disseminate the broadcast and print materials. IS staff provide summer workshops and (with assistance from technology) year-round teacher support. As the following table illustrates (on the next page), the fiscal advantage of adopting Integrated Science is as compelling as the instructional benefits.

Using the average six-year textbook cycle as a time frame, we see the total six year IS program cost is $66.24 per student while the purchase of a traditional textbook and a minimal allotment of $5.00 per year/per students for hands-on materials is $70.00. Not only is the textbook cost higher, the option does not provide teacher training annually, curriculum guides updated yearly, a classroom set of books, weekly telecast videos and coordinated lesson plans, assessment materials, $150.00 stipend, software and toll-free access to an e-mail network, and science lab kit. In contrast, all of these valuable resources are provided as part of the Integrated Science program.

CONTENT*	THE UNIVERSITY OF ALABAMA'S INTEGRATED SCIENCE	TEXTBOOK-BASED CURRICULUM
Annual Revision, updates	YES	NO
Teacher Training Every Year	YES	NO
E-Mail Support w/1400 Science Educators	YES	NO
Teacher Input Daily	YES	NO
Weekly Video Resources	YES	NO
Hands-on Activities	YES	SOME
Teacher Manuals	YES	YES
Science Kits	YES	NO
Stipend for Materials	YES	NO
Student Handbooks	YES	SOME
Student Competitions	YES	NO
Alternative/Authentic Assessment	YES	SOME
1-800 Number for Daily Support	YES	NO
Notification of New Discoveries in Science	YES	NO
Incorporation of Current Events	YES	NO
Spiraling Curriculum from Concrete to Abstract	YES	NO
Classroom Management Techniques	YES	NO
Cross-Curricular Opportunities	YES	SOME
Provides Research on Impact w/Students & Teachers	YES	NO
Cost over 6 year period	$66.24 per student	$70.00 per student

**This comparison is generic and not specific to any textbook curriculum or products. Components may vary.*

While many school systems use textbook funds to purchase IS, Eisenhower Funds (funding for math and science teacher professional development) are also used to fund IS since most of the components of the program fall under teacher professional development and items used during teacher professional development training.

INTEGRATED SCIENCE
SIX-YEAR COST ANALYSIS

TEACHER ENROLLMENT:	Year 1	Year 2	Year 3-6
Annual Fees (with Tuscaloosa inservice)	**$1,750.00**	**$1,150.000**	**$500.00**

<<Enrollment cost for 6 years: $4,900.00>>*

(Uses average teacher load of 112 students from SERVE evaluation report)	
Average yearly cost per student:	$ 7.29

Handbook Costs: Based on three year life

82 additional sets purchased in year 1: 112 sets purchased in year 4

(Each teacher receives 30 handbooks included in tuition. With an average student load of 112 students, the teacher will need an additional 82 sets of books in year 1).

Total Book Expense: 194 sets @ $13.00 = $2,522.00

Yearly student book cost:	$ 3.75
Total yearly cost per student (teacher fees and books)	$ 11.04

* This 6-year cost Includes books, 2 classroom science kits, 9 days of staff development, toll-free access to electronic network, new print materials yearly, and yearly stipend to purchase perishables.

Total IS Program 6-Year Cost Per Student:	$ 66.24

Compared to a textbook-based program Integrated Science provides more resources for 5% less money.

Textbook	$ 40.00
Professional Development ($5/year per teacher)**	$ 30.00

**This allocation would cover a 1-day workshop for 100+ teachers

Minimum Cost 6-Year Textbook Cycle Per Student:	$ 70.00

WHERE DOES THE MONEY GO?

For the direct benefit of students:		($ 5.83) 53%
Science Lab Supplies	$ .74	
Funds for Perishables	$ 1.34	
Handbooks	$ 3.75	
	$ 5.83	
For the direct benefit of the teachers:		($ 2.71) 25%
Manuals/Postage/Misc Supplies	$ .60	
Computer Network	$ .68	
Inservice Training	$ .60	
Housing/Meals	$ .83	
	$ 2.71	
As part of CCET operating costs:		($ 2.50) 22%
		=($ 11.04) 100%

TEACHER COMMENTS

"I found students helping other students prepare for tests and becoming more involved with classroom activities because of the super team concept! They would actually call each other and make sure team members were preparing for exams."

"The video telecasts provided a more in-depth study of the concepts than I would have been able to present with my limited resources and time preparation. The hands-on activities conducted in group sessions were enjoyed by students, consequently more learning (took place). Homework assignments were geared to applying science to their familiar environment. I was concerned at first with science concepts being internalized. To satisfy me, I used daily or weekly quizzes (whichever time allowed). As the year progressed, classroom discussions and the project applications proved real knowledge was being internalized by the students. The lab notebooks proved to be a real source of pride for my students. Cooperative learning forced socialization among students that would have normally been left out."

"I found that students showed enthusiasm for recognizing evidence in nature of things we had learned in class. I love to hear them tell (me) that they saw a triangular or spherical shaped pattern while traveling to Grandma's."

"In Integrated Science, all students have an opportunity to contribute in some way to the class. Every student could participate and felt like their contribution was important. The program helped them see how science applies to the real world."

"Teacher Manuals were great — made preparation for the day much easier. I was able to buy supplies or gather things needed one to two weeks in advance and have them ready. Science Sleuth and Who Am I (puzzles) had the kids running to get encyclopedias during study hall."

"Students were successful in Integrated Science and able to make better grades which made them happy and made their parents happy. Their success was due to a good, enthusiastic, prepared teacher, and the hands-on activities and (cooperative learning) groups that were very competitive and determined. Students who had failed in science made good grades, and a few of the students who were habitual at staying out of school came because they didn't want to miss science."

"Great organization, our packets were great! The staff at the U of A always answered e-mail and phone calls immediately. My students came in each day with 'What good stuff are we doing today?' The experiments were the 'good stuff' all year. They liked the videos but loved the 'good stuff.' I also used students to help with the lab table set up. They would beg for the chance to do that. Great (training) for following directions. Those that set up the tables for the 'good stuff' felt that they 'owned' that particular activity."

"Many of our mealworms turned into beetles and the visiting team saw the excitement on my students faces when they showed them to me. The students explained to the visitors about metamorphosis, the process we were studying through the mealworms. I am very proud to be part of the IS 6 program. Science has never been as fun! All the students in the lower grades have heard about the program through older brothers and sisters and they can't wait to get in my class."

GoodNews
SMITHS & SALEM
Thursday, August 8, 1996

August 8, 1996
Good News SMITHS & SALEM

Smiths' SAT scores on rise

By Becky Obert

"Our secret is our teachers," said Toby Harlan, explaining how Smiths Station Intermediate School scored above the national and state average on this Spring's SAT tests.

The administrative assistant and Title I coordinator said that a lot of teachers don't know how well their students did yet, since scores did not come in until after school ended in June.

"The ones who've come by and seen them have been thrilled," she said.

Students at the school showed improvement in every area tested, and scored an overall 55th percentile

Students at every school in Smiths Station showed improvement on the Spring 1996 SAT tests.

Third graders scored in the 49th percentile, showing a two point increase from last year's scores.

Seventh and eighth graders scores jumped four points, to the 56th percentile, while scores at Smiths Station High School rose one point, from the 46th to the 47th percentile.

"The teachers did a good job of preparing our kids for the test," said Michael Walton, principal at Wacoochee Junior High School, "not that we can't do even better next year."

He said his teachers were pleased with the scores, and are already working to improve on them next year.

"We've had departmental meetings all summer making preparations for this school year. It's kind of unusual to get teachers in during the summer, but not this year," he said.

Compounding their pleasure was the fact that this year's test was a completely new version, and schools did not receive information about the Stanford 9 until halfway through the school year.

The new test was supposed to be a more difficult version, and usually when a new test comes out, scores fall for the first year, Harlan said.

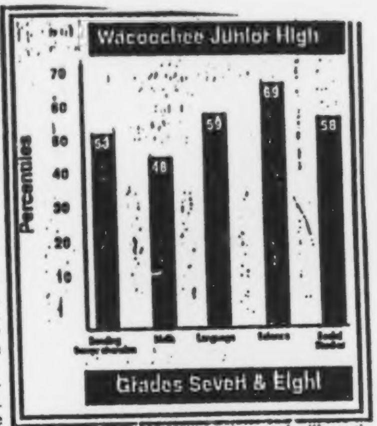
Walton said that teachers used a variety of incentives to encourage students to do their best on the tests, including pizza parties and a school dance as rewards.

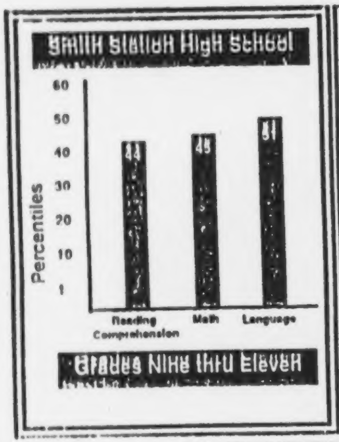
"The teachers set the tone and let student know how the test scores reflect on the school and the students as individuals," he said.

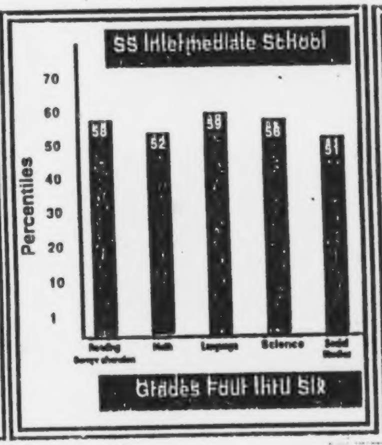
The seventh and eighth graders scored 69th percentile on science, which is "phenomenal," he said. "We've gone to an integrated science format, where instruction includes a lot of hands on things like experiments. This was our first year using it and I think we'll stick with it."

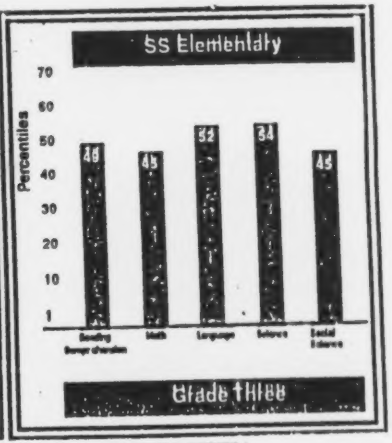
The lowest score was on the math portion, which was 46th percentile and Walton said they want to bring that up. "We have received $7,500 in school improvement funds from Mr. (John) Painter and will use the money to buy materials to improve our math instruction," he said.

See SATs
page 5









SATs

continued from page 1

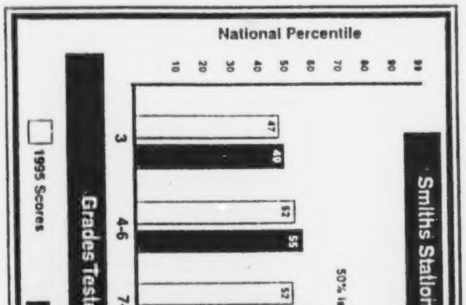
Students at the intermediate school scored above the 50th percentile on every section of the test, with highest scores in reading (58th percentile) and language (59th percentile).

"We've struggled in the past with scores not being where we wanted them, and our emphasis has been on reading, language and math," Harlan said.

"We were real fortunate that our teachers got behind this and took the time to teach children how to think logically," she said, referring to the higher order mental skills that were required by the new test.

Next year, they want to improve every score by at least one point and keep all their scores above the 50th percentile.

Carolyn Thrower, and administrator in charge of testing in the Lee County Schools, said that the district has done a lot of work emphasizing individual learning styles. "We've done a great amount of work getting information to teachers about their students," she said



March 8, 1996
Kings Bay Periscope
Camden County, GA
IS implemented in grades 6, 7, & 8

New program makes science fun for local students

By Bob Rucker
Camden County Schools

Camden County Middle School students are using a new word to describe their science courses — fun! Last year, county school officials put a new program in sixth-grade science classrooms called "Intergrated Science" and expanded the program to seventh-grade this year.

Intergrated Science gives middle school students a foundation in all the scientific disciplines (life, earth, physical, chemical, etc.) through hands-on activities, weekly video broadcasts, up-to-date student handbooks, electronic mail (E-mail) with subject matter experts and more. The program, developed at the University of Alabama and currently used by more than 165 school systems in 15 states, matches requirements of the new national standards in science.

Advantages to the Intergrated Science program are many. Unlike textbook-based science courses, materials are constantly being revised with current events.

"Technology and new discoveries are changing the world of science so quickly," said Gary Blount, assistant superintendent for Curriculum and Student Services of Camden County Schools. "It is difficult to keep pace. We normally use textbooks for seven years. That may be fine for math and literature, but in science those textbooks would be terribly out of date. Intergrated Science keeps our teachers and students current."

Students like the program, too, according to Blount. Frequent activities performed as teams using common household materials bring scientific principles to life. Competitions between teams motivate students to learn and perform. Interesting videos appeal to students and reinforce and concepts presented by teachers and the student handbook. E-mail lets students query experts and gives teachers a forum to share ideas among colleagues and offer suggestions to and ask questions of the course production staff in Alabama.

But the most important change Blount has seen since Intergrated Science started has been the improvement in student attitudes toward science.

"They're not intimidated by scientific terms and ideas now," he said. "While it is too early to tell if test scores have increased as a result of Intergrated Science, I do know that these students are far more willing and better prepared to take advanced science courses, like chemistry and physics, in high school. That is going to pay big dividends for them in the long run."

— photo by JO2 Melissa Martinez

***Intergrated Science** — St. Marys Middle School students Kendra McClellan, Jessika Dziewik and Lisa Dutton study the reproductive parts of a carnation during Mrs. Sharon Stefling's Intergrated Science Class. The sixth graders are studying "cycles" of millworms and flowers and the stages of decomposition of food, minerals and synthetics.*

INTEGRATED SCIENCE

PROGRAM ASSESSMENT AND DEVELOPMENT

Program Assessment

When CCET first developed Integrated Science, the goal was to produce scientifically literate students that would enroll in a greater number of science courses as high school students. The South Eastern Regional Vision for Education (SERVE), a federally-funded regional educational laboratory for the southeast, and the Institute for Communication Research (ICR) have conducted studies including site visits, surveys, and experiments with teachers and students since the program was first developed. School systems have also monitored teacher and student development.

Anecdotal evidence from teachers indicates that attendance has never been better, discipline problems are fewer and grades are improved resulting in fewer failures. Additionally, there are more female and minority students are enrolling in more science classes, have improved their grasp of the science process skills, and see science as relevant to their lives. **For your convenience, we have included the results of the several studies conducted on the Integrated Science project (see attached).**

Present and Future Research

Integrated Science stresses its impact on student attitudes, future interest in science, and motivation. How students perceive the classroom and science are critical outcomes. Below are some of the affective outcomes being assessed in the study on student impact currently being conducted:

- Attitudes about science in middle school
- Attitudes about science in general
- Level of interest/commitment in taking high school science courses
- Prediction of long-term science course-taking
- Self-perceived efficacy in science
- Classroom environment

Student Achievement

Student achievement is being measured by two different assessments at this time. First, the Science subtest of the Stanford Achievement Test 9 is being used to assess content knowledge in the areas of the life, physical, and earth sciences. This test was designed to allow students to use reasoning skills to find the correct answer rather than simply recalling factual information. Second, an open-ended performance assessment of science process skills has been developed to test students' skill in applying content knowledge and writing up a demonstration using the scientific method. This open-ended assessment also has an emphasis on chemistry and science-related careers which the Stanford 9 science subtest does not address. These results will be available in October of 1996.

Continued Program Development

The Integrated Science staff continues to follow the recommendations of the national science organizations as they develop, revise and refine the curricula for grades six through eight. Each Integrated Science course examines topics from the perspective of all the science disciplines, incorporates hands-on activities, utilizes cooperative learning theory, promotes higher order thinking skills, and encourages the use of journals and portfolio evaluation. **Integrated Science is changing both the "what" and "how" of science education at the middle school level.**

Equal Opportunity Program

All Integrated Science materials have been designed to serve every type of student, from the academically gifted to the educationally at-risk. CCET has been fortunate to have a large pilot group with a varied student population to test curriculum components. Schools enrolled in Integrated Science have student populations from all income strata, achievement levels, and major racial/ethnic groups. Our schools include a 99% Hispanic school in Dade County, Florida, many predominantly African-American school populations, and small isolated rural schools like Cartersville Middle School in Cartersville, Georgia. Technology is providing these schools equal access to the best educational resources available. Offering these kinds of resources to everyone should eventually reduce the science achievement gap between the most advantaged and disadvantaged students.

Researcher: South Eastern Regional Vision for Education (SERVE)
Date: March 1995
Name: 1994 Evaluation Results of the Integrated Science Program
Methodology: Surveys to Integrated Science Teachers

Results:

Surveys of teachers attending the inservice program for implementing IS curriculum. "Beginning" teachers completed surveys before and after inservice. At sessions for "returning" teachers, surveys were completed after the inservice.

- 69% of "returning" teachers reported that their enthusiasm for teaching had increased.
- 60% of "returning" teachers reported students using science process skills at least once a week.
- 44% of "returning" teachers reported that the IS telecasts exposed students to a wider variety of information than is possible without telecasts. 32% of teachers say this is true always.

Activities	Beginning Teachers	Returning Teachers
■ Students explore and discuss phenomena through hands-on investigations	40%	88%
■ Students work together in cooperative groups	60%	92%
■ Students develop hypotheses, make predictions and state conclusions	29%	60%
■ Students collect and interpret data	30%	64%
■ Teachers feel very prepared to teach science	74%	91%

Researcher: South Eastern Regional Vision for Education (SERVE)
Date: June 1995
Name: Holmes Middle School in Eden, North Carolina
Methodology: Focus groups with IS teachers and students at all grade levels

Results:

- The IS program promoted a greater use of hands-on activities and cooperative learning among the students.
- Teachers believed that the videos were central to the program because they go places and interview experts that the teachers and students don't have access to.
- Teachers also liked the freedom and flexibility they had in choosing what to use.
- Teachers liked the opportunities that the IS program provides for students to learn scientific methods, to become critical thinkers and observers, to work well in groups and to improve communication skills.
- Teachers also praised the opportunities to succeed for students with different learning styles.
- The students stressed that the IS system makes science "fun" and easier to learn.

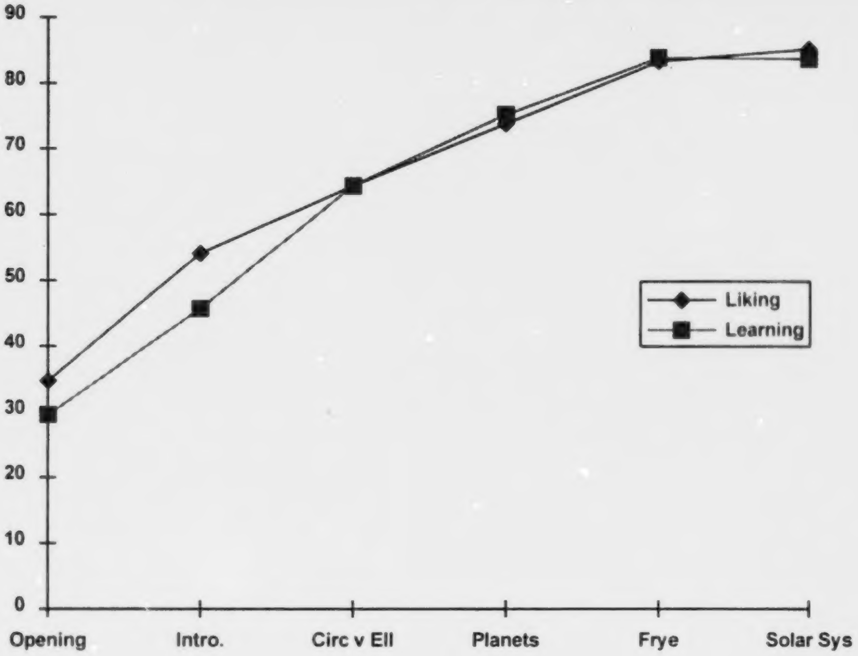
Researcher: McGill University, Quebec, Canada
Date: January 1995
Name: Interviews with teachers and students using IS in Quebec
Methodology: Interviews with teachers and students

Results:

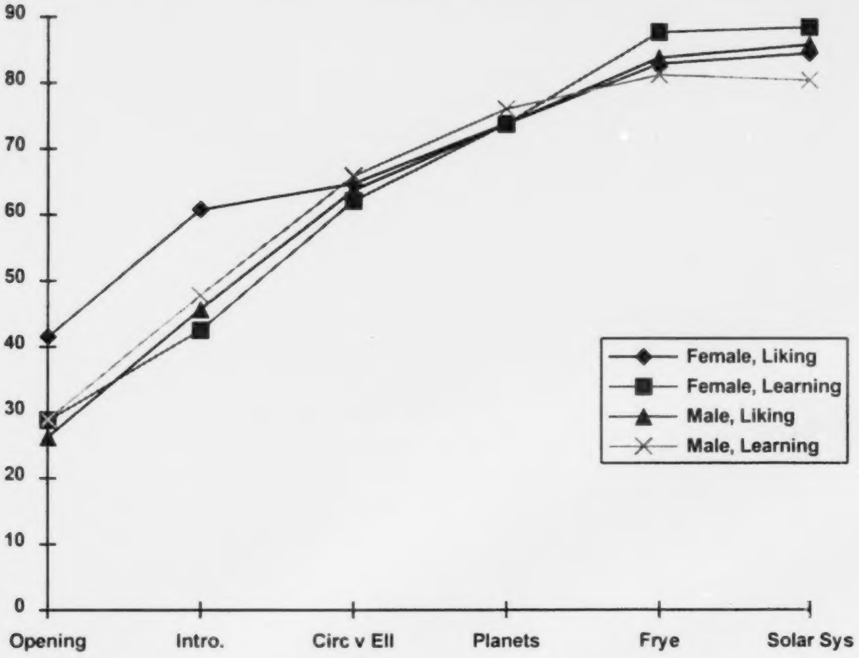
- Teachers use the IS program to integrate science into other subject areas like mathematics, language arts or social studies.
- Teachers believe IS to be accurate, current and interesting to students.
- The IS approach increases teacher comfort. Teacher confidence is fostered by inservice, new material, toll-free assistance and e-mail contact.

Researcher:	Institute for Communication Research
Date:	January 1996
Name:	Amory, Mississippi Site Visit
Methodology:	Interviews/Surveys with Integrated Science Students

IS8 Line Graph of Liking and Learning Responses Per Segment



IS8 Line Graph of Liking and Learning Responses by Gender Per Segment



INTEGRATED

SCIENCE

The University of Alabama

CURRICULUM SAMPLES

Grade 6

Table of Contents:

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Assessments..........27

CLUES 17 - "HYPOTHESIS HYPE"

I. MAIN IDEA : Hypotheses lead to predictions.

OBJECTIVE A – Questions lead to hypotheses.
OBJECTIVE B – An hypothesis is a tentative answer to a problem or question.
OBJECTIVE C – An hypothesis and its prediction can be expressed as a "If...then" statement.
OBJECTIVE D – An hypothesis can be tested by an experiment.

The main idea of this lesson is: Hypotheses lead to predictions. Mrs. Cannon visits The Land exhibit at Epcot center in Walt Disney World, Orlando, Florida, to explore how the scientific method is used to care for the beautiful plants all around the park. A pest called the leaf miner was damaging the plants in the park. Epcot's entomologists, scientists who study insects, were interested in using other insects to control the leaf miner. They knew that parasitic wasps attack leaf miners by laying eggs in them. To identify how many wasps would be needed to bring the leaf miner problem under control, they placed 50 female wasps in a cage with plants infested with 1,000 leaf miners. The hypothesis they were testing was IF 50 female wasps can produce 1000 larvae THEN all the leafminers will be parasitized. Their tests led them to conclude 80 female wasps could parasitize 1,200 leaf miners.

Mrs. Cannon explores the hypothesis as an "If ... then ..." statement. She explains that the statement that follows the "If" is the hypothesis or the tentative answer or solution to a problem and that the statement that follows the "then" is a prediction based upon the hypothesis. Examples include "If I save my allowance, then I can buy a new CD" and "If I wash my dad's car, then he will raise my allowance."

Scientists are not the only ones who make and test predictions. Students are seen hypothesizing about how their parents will respond to their request to go to a movie sneak preview on a school night. One student believes that if he washes the family car, his parents will allow him to attend the preview. Another student believes that if she does her homework, her parents will allow her to attend the movie. The final student reasons that if the other parents let their children attend, his parents will also let him go to the preview. Later, the students return to reveal the results — students one and three are allowed to attend, while student two is not.

Veterinarians use clues to form hypotheses in diagnosing patients. In this segment, a veterinarian, Dr. Kenneth McLendon is assessing the symptoms of a sick dog to diagnose its illness. He suspects heart worms. He observes the dog's size, takes his temperature, looks at his mouth, listens to his heart, and performs tests for parasitic worms. These tests include an examination of the dogs blood for microfilaria (microscopic worms) and a test for antigens in the dog's blood. (Antigens are foreign proteins. In this case the foreign proteins would be those of the parasitic worm that is suspected of causing the dog's illness.)

Next, Mrs. Cannon visits Tuskegee University in Tuskegee, Alabama where Forrest Ledbetter, an IS 6 teacher and two of his students tell us about George Washington Carver. Dr. Carver was the head of the Department of Agriculture at the University. Although he was born a slave and orphaned at an early age, he had a burning desire for an education. While at the University, he performed many scientific experiments on food plants such as the sweet potato and peanut. Today, research on the sweet potato continues at the university. NASA has commissioned a study on the hydroponic growing of sweet potatoes as a potential candidate for growth in space. These studies are necessary for two reasons. First, it is less expensive to grow food in space than to transport the food to space from Earth. This will be a major consideration for future long term space missions. Second, in space, soil would float around in the anti-gravity environment, so alternative growing mediums are being explored. Hydroponics uses nutrient rich water solutions as the growing medium instead of soil. Dr. Jill Hill describes the experiments underway at this time to determine an optimal temperature range for growing space crops. The hypothesis is: IF an optimal temperature range can be identified, THEN sweet potatoes can be grown with other candidate crops for long term space missions. The current research has identified a temperature range of greater than 18 degrees Celsius and below 28-30 degrees Celsius.

Interactivity tip: Discussing each hypothesis as they appear will help many students understand the process of making a hypothesis. Teachers should note that there are two possible assessments for this activity being provided so that teachers may choose the assessment they feel is best suited to their students.

CLUES 17 **NAME**____________________

TELECAST ASSESSMENT SHEET
"Hypothesis Hype"

I. PRE-VIDEO QUESTION:(3 pts)

What do you already know about the scientific method?
In the space below, use pictures, words, lines, arrows, etc. to show what you know about the scientific method. (This way of illustrating what you know is called a CONCEPT MAP.)

II. POST VIDEO QUESTION:(6 pts)

What do you know about the scientific method after viewing the video? In the space above, below, or on the back of this sheet, use pictures, words, lines, arrows, etc. to show what you NOW know about the scientific method. If you add to what you did above, make sure you use another color pen or pencil to show your new understanding. Make a mark with the pen or pencil you will use in this part (here) ___________.

Total Points = 9 **TOTAL PTS _____**

CLUES 17 a **NAME**____________________

TELECAST ASSESSMENT SHEET
"Hypothesis Hype"

I. PRE-VIDEO QUESTION:(2 pts)

In the space below describe a problem, real or imaginary.

II. INTERACTIVE QUESTION: (6 Pts)

Write a possible answer or solution (hypothesis) to the above problem.

Write a possible prediction of the hypothesis you wrote above.

Combine the hypothesis and prediction you wrote into an "IF...THEN..." statement.

III. POST VIDEO QUESTION:(2 pts)

```
growth
     |
     |
     |   X  X
     |   X  X
     |   X  X
     |   X  X  X
     |__X__X__X__X_
     0 10 20 30 40 C
```

If the graph above represented the results of Dr. Hill's sweet potato experiment, what would she have concluded?

Total Points = 10 **TOTAL PTS** _____

OBJECTIVES: BLOCK I — CLUES

I. Science Process Skills

A. Use all the senses to make observations.

- describe how we use the senses (sight, touch, smell, taste and hearing) to make observations
- give examples of tools that are used to extend the senses (for example: hand lens, microscope, electron microscope, telescope)
- make qualitative and quantitative observations
- use instruments to make and record metric measurement
- understand that observations can lead to clues about the past, present, and future
- describe how clues offer information to archaeologists, paleontologists, astronomers, and forensic scientists

B. Classification

- classify things based on their characteristics and properties
- classify objects as being symmetrical or asymmetrical
- classify organisms based on their type of symmetry (radial or bilateral)

II. Scientific Method

Use the strategies of the scientific method.

- formulate a scientific question based on observations
- recognize what makes up a scientific inquiry
- recognize that experiments have variables and controls

WEEK SIX LESSON PLANS

RECORD MACHINES 1-3

DAY 26

October 7, 1996

HOMEWORK: 95 & 96-97: Clues: Using the Scientific Method, "Think About It," pp. 49-50, and "Believe It or Not," pp. 50-51.
93-94: Clues: Using the Scientific Method, "Think About It," pp. 58-59, and "Believe It or Not," pp. 60-61.

TELECAST: CLUES 16 ¾ THERE'S METHOD TO THE MADNESS

The main idea is: **The scientific method follows a predictable pattern.**

CLASSROOM: Students discuss the telecast and complete the Telecast Activity Sheet.

DAY 27

October 8, 1996

HOMEWORK: 95 & 96-97: Clues: Using the Scientific Method, "Brainy Bits and Bytes," pp. 52-54.
93-94: Clues: Using the Scientific Method, "Brainy Bits and Bytes," pp. 62-64.

TELECAST: NONE

CLASSROOM: Group Activity ¾ CLEVER KITCHEN CHEMIST

EMPHASIS: This activity allows students to make observations and draw inferences based on experimental results.

BACKGROUND:

In this experiment, students learn to become chemical detectives. The object of this activity is to discover some of the properties of a few common household powders, using equally common household liquids. When the groups discover the properties of the known powders and can tell them apart, they are given a mystery powder which is made from a mixture of the known powders. Using the liquids and their previous observations, they identify their mystery mixture.

Substances can be characterized and identified by their individual and specific properties. Properties such as color, melting and boiling points, density, or anything that can be measured and observed without changing the composition or identity of a substance is a physical property of a substance. Some properties that are observed depend upon a chemical change taking place between two substances and are, therefore, chemical properties. The properties of the substances in this activity that can be easily seen are the substances' color and, with the aid of a magnifying glass, its crystalline nature. Whether a substance is soluble in water and to what degree gives a clue about the makeup of the substance. Substances made up of salts or small molecules are soluble in water, whereas large molecules like starch or

fats are not soluble in water. Baking soda, for example, dissolves in water-producing sodium ions and bicarbonate ions. If heated, this solution produces sodium carbonate and carbon dioxide gas. However, if the sodium bicarbonate is added to vinegar (acetic acid) then sodium acetate as well as carbon dioxide gas is produced. Baking powder is a mixture of baking soda (sodium bicarbonate), an inert filler and cream of tartar. It looks different, but reacts similarly to vinegar. The iodine test can be used to measure the amount of starch present in a solution and is very specific for starch. The starch reacts chemically with the iodine solution turning blue-black, whereas all the other substances are unaffected.

The mystery powder can be combinations of the following substances. Their reactions are below.

	Water	**Acid**	**Iodine Solution**
Baking soda	Very sol.	Gives off gas	No color change
Baking powder	Soluble	Very little gas	No color change
Starch	Not sol.	No gas	Turns blue black
Creamer	Soluble	No gas	No color change

MATERIALS (per group):

plastic wrap or waxed paper
toothpicks
plastic spoons
plastic or paper cups
eyedroppers or plastic straws
magnifying glasses (or microscopes)
powder kitchen chemicals: baking soda, baking powder, cornstarch, and coffee creamer.
liquid kitchen chemicals: distilled water, vinegar (which is acetic acid), iodine solution (mix 40ml of water with 5 drops tincture of iodine.)
mystery kitchen chemicals*
Clever Kitchen Chemist Grid Sheet
Clever Kitchen Chemist Observation/Data Sheet
Clever Kitchen Chemist Activity Sheet

***Teacher Tip:** We suggest using one of the following combinations for the mystery powder: 1) baking powder and cornstarch, 2) cornstarch and coffee creamer, 3) baking soda and coffee creamer, or 4) baking soda and cornstarch.

PROCEDURE SUMMARY:

Groups observe the physical and chemical properties of common kitchen solids when mixed with household liquids and use their observations to determine the contents of an unknown mixture.

PROCEDURE INSTRUCTIONS for CLEVER KITCHEN CHEMIST:

1. Assign tasks in your group. You need: a secretary to record observations, a manager to place the right solids on the right squares, a chemist to put the right liquids on the correct solids, and an analyst to make observations.

2. Cover your observation grid with some wax paper or plastic wrap.

3. Put a very small (pinhead size) sample of each powder (baking soda, cornstarch, creamer, baking powder) in the appropriate squares in each row.

4. Make observations about each powder and record them on the data sheet. Use a magnifying glass or microscope to note the color, size, and nature (crystalline or not) of the powders. DO NOT TASTE ANY OF THE CHEMICALS!

5. Use the eyedropper to put a few drops of water on the baking powder (make sure you have the correct square) and mix it with a toothpick. If it seems too dry, add a few more drops. Look for color changes, solubility (does the solid dissolve into the liquid?), and obvious chemical activity like fizzing or giving off of gas. In some cases, you might see a precipitate (the solid dissolves into the liquid, and then a different solid is formed).

6. Record your results on the observation/data sheet.

7. Repeat steps 5-6 for all the solids in the water column.

8. Using vinegar, repeat steps 5-6 for all the solids in the vinegar column.

9. Using iodine solution, repeat steps 5-6 for all the solids in the iodine column.

10. Now, collect an unknown mixture from your teacher. This mixture is a combination of two of the chemical solids you have tested today.

11. Run steps 3-6 on this mystery mixture.

12. Based on your observations of the individual powders and the analyst's tests, complete the Activity Sheet. Submit the sheet to your teacher, and find out if you were right.

DAY 28

October 9, 1996

HOMEWORK: 95 & 96-97: Clues: Using the Scientific Method, "Sleuth Alert!," p. 55, and "Read On!," p. 56.
93-94: Clues: Using the Scientific Method, "Sleuth Alert!," p. 65.

TELECAST: CLUES 17 ¾ HYPOTHESIS HYPE

The main idea is: **Hypotheses lead to predictions.**

CLASSROOM: Students discuss the telecast and complete the Telecast Activity Sheet.

DAY 29

October 10, 1996

HOMEWORK: 95 & 96-97: Clues: Using the Scientific Method, "Homework: Solution or Solid", p. 57.
93-94: Clues: Using the Scientific Method, "Homework: Solution or Solid", p. 66.

TELECAST: CLUES 18 ¾ ELEMENTARY MS. CANNON!

The main idea is: **Experiments test hypotheses.**

CLASSROOM: Students discuss the telecast and complete the Telecast Activity Sheet.

WEEK 6 DAY 27 **NAME** ____________

Clever Kitchen Chemist Activity Sheet

As your group Analyst tests the mystery powder with each of the liquids, please record your observations here. (1 pt each; 6 pts total)

CLEVER KITCHEN CHEMIST GRID SHEET

	DISTILLED WATER	VINEGAR	IODINE SOLUTION
POWDER 1			
POWDER 2			
POWDER 3			
POWDER 4			

MYSTERY POWDER			

For more information on The University of Alabama's INTEGRATED SCIENCE call Kim Mitrook at 1-800-477-8151.

CLEVER KITCHEN CHEMIST
OBSERVATION / DATA SHEET

	DISTILLED WATER	VINEGAR	IODINE SOLUTION
POWDER 1	CHARACTERISTICS OF POWDER: (color, texture, other)		
	Does the powder dissolve in water? _____ Is there a color change?_____ Does it fizz?_____	Does the powder dissolve in vinegar? _____ Is there a color change?_____ Does it fizz?_____	Does the powder dissolve in iodine solution? _____ Is there a color change?_____ Does it fizz?_____
POWDER 2	CHARACTERISTICS OF POWDER: (color, texture, other)		
	Does the powder dissolve in water? _____ Is there a color change?_____ Does it fizz?_____	Does the powder dissolve in vinegar? _____ Is there a color change?_____ Does it fizz?_____	Does the powder dissolve in iodine solution? _____ Is there a color change?_____ Does it fizz?_____
POWDER 3	CHARACTERISTICS OF POWDER: (color, texture, other)		
	Does the powder dissolve in water? _____ Is there a color change?_____ Does it fizz?_____	Does the powder dissolve in vinegar? _____ Is there a color change?_____ Does it fizz?_____	Does the powder dissolve in iodine solution? _____ Is there a color change?_____ Does it fizz?_____
POWDER 4	CHARACTERISTICS OF POWDER: (color, texture, other)		
	Does the powder dissolve in water? _____ Is there a color change?_____ Does it fizz?_____	Does the powder dissolve in vinegar? _____ Is there a color change?_____ Does it fizz?_____	Does the powder dissolve in iodine solution? _____ Is there a color change?_____ Does it fizz?_____

For more information on The University of Alabama's INTEGRATED SCIENCE call Kim Mitrook at 1-800-477-8151.

DAY 30

October 11, 1996

HOMEWORK: 95 & 96-97: Clues: Using the Scientific Method, "Homework: Pick-a-Problem," p. 57. Optional: "S.U.P.E.R.C.H.A.L.L.E.N.G.E," p. 57.
93-94: Clues: Using the Scientific Method, "Homework: Pick-a-Problem," p. 66. Optional: "S.U.P.E.R.C.H.A.L.L.E.N.G.E," p. 66.

TELECAST: NONE

CLASSROOM: Group Activity ¾ BUBBLE BLOWOUT

EMPHASIS: This activity gives students the opportunity to test a hypothesis using the scientific method.

BACKGROUND:

The scientific method is a formalized way of explaining how and why things happen in the natural world. Through the trio of observation, hypothesis and experiment scientists go about their business of trying to learn about the universe. Usually, as presented to students, the scientific method consists of defining the problem, gathering the facts, hypothesizing, testing the hypothesis through experimentation and reaching conclusions based on the data gathered. The protocol of science varies from teacher to teacher but one thing is certain, observations are used to either formulate a generalization or question about a phenomena. Inductive logic is used when making observations and formulating the generalization, which is then questioned and used to generate hypothesis. The more observations made, the more likely that the generalization made is true.

A hypothesis (prediction) tries to make sense of the data and observations by coming up with a tentative answer, or as it is often said, "a scientific guess."

In that a hypothesis is a guide to future investigation or that it is a statement assumed for the sake of argument and testing, it often assumes an "IF..., THEN..." form. The IF is followed by the hypothesis or tentative answer to a problem or observation. The THEN is followed by a prediction made from the tentative answer or hypothesis. Stated in another way, when hypotheses are formulated, they often take the form **If:** A is true, **Then:** B is true. A is the hypothesis or premise to be tested and B is the experimental observation to be made. The testing of a hypothesis involves deductive logic. Deduction does not generate new knowledge, but it proposes experiments that either support or disprove the hypothesis or major premise. Using deduction you cannot prove a generalization from one supporting argument. After all, there might be exceptions not yet known. Summing up, if A is being tested and B is the experimental observation to be made, if B is false, A must be false, however, if B is true, A may or may not be true.

A good hypothesis is one that lends itself to testing. A good experiment is one that is set up so that a single variable is being tested. A control represents a standard to compare the results of an experiment to. Without controls you cannot be sure the results of an experiment are really due to the factor that is being tested. In an experiment dealing with blowing bubbles you could not be sure the soap was responsible for the bubble unless you had a control using water as a basis for comparison. If glycerol is added to the mixture of soap and water, then a control to rule out glycerol as well as water is necessary.

In most experiments, after the data is in and conclusions are made, new questions arise or generalizations are made. The process continues with the trio of observation, hypothesis, and experiment.

MATERIALS (per group):

- glycerin
- water
- measuring cup or graduated cylinder
- 3 containers for mixing bubble solution
- 3 medium size plastic garbage bags
- 3 lab data sheets
- plastic straws (one per student)
- 3 metric rulers
- small samples of each brand to be tested
- calculator
- Bubble Blowout Activity Sheet

PROCEDURE SUMMARY:

During a telecast assessment, students will have hypothesized which of 3 brands of dishwashing liquid will make the biggest bubbles. Each member of the group conducts a bubble blowing test for each of the different brands of dishwashing liquid, and class averages are calculated.

TEACHER PREPARATION for BUBBLE BLOWOUT:

Steps 1-5 may be done before class, if desired.

1. Place 120ml of water in a large beaker.

2. Add 5ml of glycerin to the beaker.

3. Add 20ml of one sample of dishwashing liquid to the beaker and stir it EXACTLY 10 times.

4. Repeat steps 1-3 for the other two dishwashing liquid samples.

5. Cover a desk or table top with a plastic bag. Repeat this on two more desks. Leave a lab data sheet at each "station" for recording the bubble trials.

6. Pour 40ml of one mixture onto a plastic garbage bag. After moistening the entire surface of the bag, pat the liquid to form a bubbly area in the center of the bag. Add a little more if needed.

7. Using the other mixtures, repeat step 6 for the other two stations.

WEEK 6 DAY 30 GROUP ____________

Bubble Blowout Activity Sheet

As a group, please write the hypothesis which you plan to test.

If ____, then______________

____.

Directions: Each group member conducts a bubble blowing test for all three brands of dishwashing liquid, recording his or her results on a separate sheet of paper. Before you begin, make sure all samples were labeled as Brand X, Brand Y and Brand Z. Each student calculates and reports his/her average size for each brand to the group reporter who fills in this table.

Record the diameter of the soap bubbles in centimeters.

Student	Brand X	Brand Y	Brand Z
Group Average			
Class Average			

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WEEK 6 DAY 30 **GROUP** ______________

Bubble Blowout Activity Sheet KEY

As a group, please write the hypothesis which you plan to test.

If ____, then ____________

ANSWERS WILL VARY; ACCEPT ANY REASONABLE HYPOTHESIS

____.

Directions: Each group member conducts a bubble blowing test for all three brands of dishwashing liquid, recording his or her results on a separate sheet of paper. Before you begin, make sure all samples were labeled as Brand X, Brand Y and Brand Z. Each student calculates and reports his/her average size for each brand to the group reporter who fills in this table.

Record the diameter of the soap bubbles in centimeters.

Student	Brand X	Brand Y	Brand Z
Group Average			
Class Average			

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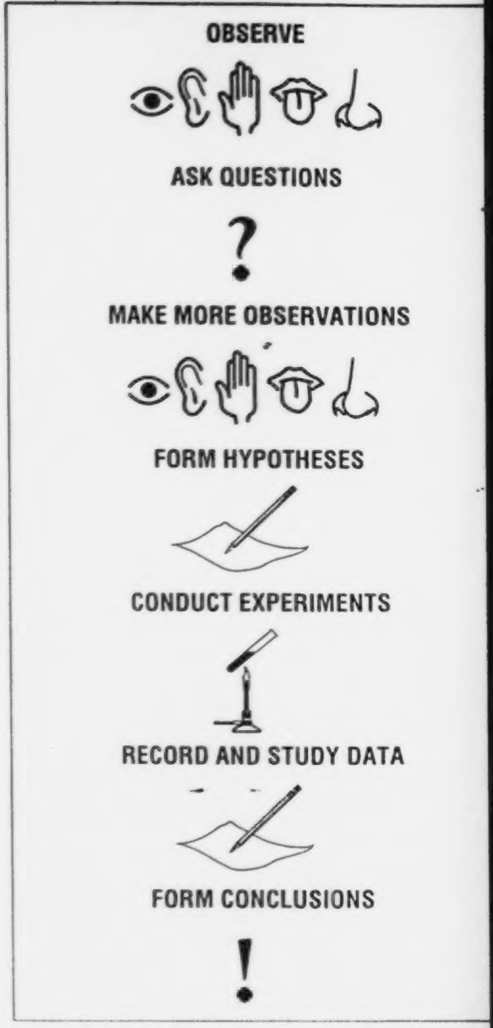
Think About It

Many scholars think that modern science began around 1600 with Isaac Newton's study of the universe. Newton is often referred to as the father of modern science. Both his ideas about the universe and his approach to science were revolutionary. Unlike many great thinkers who had written about science before him, Newton refused to consider ideas that could not be demonstrated. He based all of his theories on observations of natural ***phenomena*** — a word which means observable facts or events. He described his method as "the method of analysis and synthesis," what the world has come to call "the scientific method."

Other scientists (like Galileo and Brahe) working at that time accepted his idea that observation and experimentation were the keys to science. Much of Newton's work benefited from the experiments of others. Newton thought of the universe as clock-like and he produced a set of laws that described its motion. For the first time scientists saw that . . .

Many things in the universe are regular and predictable.

Adopting the scientific method caused a lot of frustration. Much of the natural phenomena observed was not understood because at that time scientists did not grasp the concept of energy. But that topic and many other mysteries were unraveled during the next 100 years, as scientists around the world developed a systematic approach to science. Here are some of the things scientists do when they carry out a sci tific investigation:



OBSERVE

ASK QUESTIONS

MAKE MORE OBSERVATIONS

FORM HYPOTHESES

CONDUCT EXPERIMENTS

RECORD AND STUDY DATA

FORM CONCLUSIONS

continu

Think About It, *continued*

Scientists often talk about having a plan or ***protocol*** for an experiment. When they use this term, they are setting up the scientific method. Using a protocol helps scientists remember how they worked. This is especially important when experiments are repeated in order to check results, or when work is being done in several different research centers at the same time.

The scientific method is a great way to figure something out, or solve a problem. But don't worry — using the scientific method does not mean throwing away your own ideas. Scientists often have a new theory or creative idea in mind when they set up an experiment. The scientific method simply helps us achieve a more complete understanding of what we are studying. It also helps to remind us that we should be willing to change our ideas when the data demands it. It is indeed the method of choice for science sleuths.

BELIEVE IT OR NOT

Jason couldn't believe all the attention he was receiving. When he awoke the morning after the museum incident, it almost seemed as if he had dreamed the whole thing up. His picture had appeared on the evening newscast, and now all his classmates had gathered at the school's front steps to greet their new celebrity. A newspaper reporter was at the scene, ready to take down every word he said.

Jason stood on the school steps, surrounded by his fellow students. They were staring at him in awe, amazed that one of their classmates had been able to solve the mystery of the missing pearls. The newspaper reporter stood waiting with her notepad and pencil ready. She was looking at Jason like he was some kind of hero — just because he had been able to figure out a mystery! Everyone was quiet, waiting to hear what he had to say.

"Uh, I just used the scientific method!" Jason admitted. "Even kids can figure out lots of things if they use the scientific method." Everybody looked surprised. Mutterings of agreement and approval drifted through the crowd.

BELIEVE IT OR NOT, *continued*

"Exactly what is the scientific method, Jason?" the reporter asked. "And how did it help you solve your case?"

Jason's classmates were looking at him curiously, waiting for him to speak. "The scientific method is a process that begins with making observations. Observations lead to questions, which lead to more observations. After awhile you have enough information to form an hypothesis and test your ideas. Everybody learns about this in science class, but most people don't realize you can use the scientific method in everyday life. All kinds of people, like detectives, use the scientific method every day. It helps you solve problems."

Somebody in the crowd yelled, "Yeah, but don't you need fancy microscopes and other kinds of equipment to use the scientific method?"

"You don't have to have any equipment to use the scientific method," Jason said. "Take Aristotle, for example. He was a Greek philosopher and scientist who lived around 300 B.C., long before microscopes or any other scientific equipment had been invented. He had his own method for classifying plants and animals. Through observations and note-taking, he actually wrote a description of the development of a hen's egg that was completely accurate. Modern scientists are amazed that he could do all of that without a microscope. If you do hands-on science like we do at this school, you get pretty good at doing this kind of stuff."

"Well, Jason, you certainly have given us a lot of information." The reporter pulled her camera out of her bag. "How about a shot of you surrounded by all your classmates?"

All Jason's friends rushed to gather around him. A fe of the tall boys hoisted him up on their shoulders. "Alrig Jason," they cried. "Science is way cool!" Jason was real beginning to feel like a hero. "Smile for the camera," said t reporter. Jason grinned his biggest grin, all his classmat grinned, even the reporter grinned.

That afternoon, the Goose Creek Gazette ran a lar picture of Jason on the front page. It showed him bei hoisted into the air by his classmates. The headline above t picture said it all:

Riches Recovered, Earl Jailed, Jason Hailed

BRAINY BITS & BYTES

Scientists are "super sleuths" who study the mysteries of our universe. They are good investigators and enjoy hunting for clues, because finding clues often means solving a mystery. You can become a super sleuth, too, if you use the same techniques that scientists do when they perform an investigation.

Scientists like to explore the natural world. When they do an investigation they use both their imagination and strict test procedures. Even though they may appear to approach every problem differently, there is always some "method to their madness." The steps and details vary from problem to problem or scientist to scientist, but there is always a reason for what is done. Eventually, evidence is gathered, hypotheses are formed and tested, data is collected and analyzed, and conclusions are drawn. Together, these techniques are known as the ***scientific method.***

So, to become a super sleuth, you need to be curious. This is one of the most important traits of a good scientist; he or she looks at the world, sees interesting things and asks questions: why; how; what if? When you find a question you want to investigate, it's helpful to do more observations and gather all the clues you can find — just like a detective. Then you can form an hypothesis. An ***hypothesis*** is one possible answer to your question. So it is actually an "educated guess" or prediction about why something happens or how an event will turn out. It is called an educated guess, as opposed to a wild guess because you use clues that you've read or observed to form it.

To illustrate, let's pretend that your dog has had puppies. In fact, she had six! Of course, you plan to keep them all and take care of them yourself. But your mother is not thrilled with the expense of feeding all of these animals. She has told you that you'll have to start paying for their puppy food out of your allowance.

So you decide to accompany your mother to the grocery store and explore the dog food aisle. There are several brands of puppy food on the shelves. You find the two brands your mother suggested. One, an economical store brand called *Food Market's Best* has **"Super Low Price"** written in bold red letters across the bag. The other, a highly priced name brand called *Woofer's* has **"Puppies Thrive On It"** — their advertising slogan — on the bag. Now, which brand should you choose? Should you buy the well-known and possibly more nutritious national brand, or save your money and buy the less expensive store brand? Will it make a difference?

Your mom tells you that she has started feeding the puppies *Woofer's* because the puppies on their TV commercial really gobble it up. But when you check the labels you find that both brands have the same ingredients. So won't the puppies do as well eating either brand?

"Let's go about this more scientifically," you say. "We can use the scientific method to conduct an experiment. I'll ask the veterinarian how I can tell if the puppies who eat the store brand are as healthy as the puppies who eat *Woofers.* Once I have that information, I can develop my hypothesis."

For more information on The University of Alabama's INTEGRATED SCIENCE call Kim Mitrook at 1-800-477-8151.

"Whatever you say, dear," says your mother as she hurries off to see what's on sale at the meat counter. Later, you telephone your vet to discuss your problem. She tells you that she knows a puppy is healthy if it gains ten percent of its birth weight every month and has a shiny-looking coat.

After thinking about what hypothesis to use in setting up your experiment, you decide on ...

If the store brand of puppy food is as good for puppies as *Woofers*, then the puppies will all be healthy.

Notice that the words "if" and "then" were used. An hypothesis is often written this way because it emphasizes a cause (if...) and effect (then...) relationship.

A good hypothesis can be tested. The test is called an ***experiment***. The condition tested is known as the ***variable***.

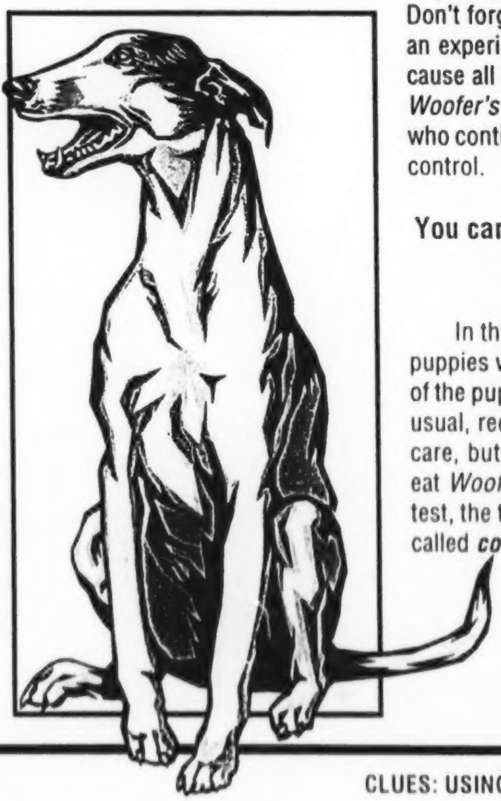
A variable is any factor that can change in an experiment.

A successful experiment tests only one variable at a time, which is why you can scientifically compare only one new brand of puppy food with the brand the puppies are eating now. The reference to the variable should also be very specific. So let's look at our hypothesis again. "Will be healthy" is probably too general a phrase to use in an hypothesis. We need to write a new one that will make it obvious what variable we are testing.

If *Food Market's Best* is as healthy for puppies as *Woofer's* brand, then puppies who eat the *Food Market's Best* will gain as much weight as tho who eat *Woofers*.

Okay, that makes things clearer. Now we know that are going to measure the puppies' weight gain. Stating bot the brand names of the puppy food in the hypothesis also avoid any confusion about the results.

So you have your hypothesis and you've bought one of *Food Market's Best* and one bag of *Woofer's* puppy fo This is sort of fun. Let's go ahead and set up your experim



Don't forget that whenever you perfo an experiment, you need a ***control.*** cause all your puppies began life eat *Woofer's* brand, the group of pupp who continue eating *Woofer's* will be control.

You can't perform an experime without a control.

In this experiment, three of your puppies will be the control group. All of the puppies will go about their lives usual, receiving the same kind of lov care, but three puppies will continue eat *Woofer's* puppy food. In a scient test, the things that remain the same called ***constants***.

contin

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Everything except the variable being tested must remain constant.

Fill the feeding bowls of the puppies in both your experimental and control groups three times a day. Weigh the puppies on the first day and then again every 10 days for a month. Compare the amount of weight gained by the puppies in each group. Was your hypothesis correct — do the puppies eating *Food Market's Best* gain as much weight as the ones that ate *Woofer's*? If your hypothesis is supported, you will probably want to ask other friends with new puppy litters to conduct the same experiment to see if they obtain the same results.

When a scientist finishes an experiment, he or she writes up a formal ***conclusion***. The conclusion reports the results of the experiment and states whether or not the hypothesis still seems reasonable. In this case, your experimental group of puppies was fed the same amount of *Food Market's Best* as the control group received of *Woofer's*. If their weight gain was equal, then your conclusion would state that "My puppies gained as much eating the *Food Market's Best* brand of puppy food as they did eating *Woofer's* brand. Based on the results of my experiment, I would recommend that this hypothesis be tested further."

Can you think of some problems you would like to solve using the scientific method? If you ask the right questions and are able to answer them, you will obtain lots of information that is helpful to you, your friends, or your parents. You may even discover answers to a problem that no one else has found. Learning and making discoveries are two things that make science very exciting.

Solution or Solid

Here is a neat way to put the scientific method to work. Every household has lots of chemicals. As part of your science sleuth training, we want you to identify a few and study one of their characteristics. Look around and select five liquids like salad oil, dishwashing detergent or shampoo, bleach, window cleaner, vinegar, etc.

To do this experiment you will need a clean, plastic ice cube tray. Carefully pour at least five different substances into the various ice cube compartments. Be sure to keep them separate — you do not want any of these liquids to mix. As you pour in the various substances, draw a chart of the tray showing what product went where. Include the tradename of the product as well as any chemicals listed on label. Write a hypothesis (prediction) stating what you thi will happen to the liquids in the freezer. Ex.: If shampoo is in the freezer, then . . .

Place the ice cube tray in the freezer and leave it there at least 10 hours. On the next day, examine the tray a indicate on your chart whether or not the substance in ea compartment changed phase. In other words, did it becom solid? Don't forget to wash the tray very carefully with so and water when you are finished with it. Somebody mig need it to make some ice cubes!

Pick-A-Problem

Scientists are not the only ones who solve problems using the scientific method. Any time you gather facts about a situation and try to figure out what they mean is a good time to use this protocol. If you visit the doctor because you feel ill, he or she usually listens to your symptoms and then conducts some tests to gather more information. After the doctor has studied the data, he or she makes a diagnosis or draws a conclusion about what is wrong. Mechanics and repairmen use the same method.

For tonight's homework, pick a problem that has bothered you or someone in your family. Maybe it's a broken lamp or toy, or something that is not working right with your family's car. Identify the problem and then explain how you would use the scientific method to find a solution to the problem.

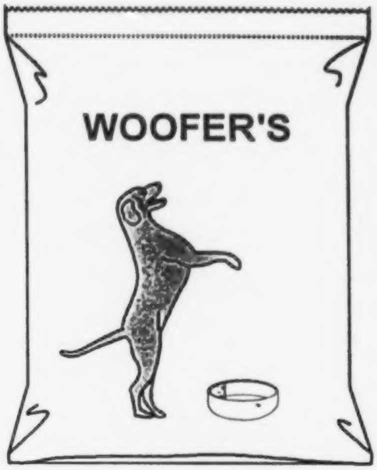
SUPER ☆ CHALLENGE

After you complete the Pick-A-Problem homework, draw a flowchart that diagrams your analysis. A flowchart is an illustration of the steps in a procedure.

Week 6 Day 27 **Name:**____________________
Homework Sheet

Homework: Clues: Scientific Method, "Brainy Bits & Bytes," pp. 62-64. (95: "Brainy Bits & Bytes," pp. 52-54.)

Summarize the puppy food experiment by describing each of the following:



A. The question to be investigated:

B. The observations made:

C. The hypothesis:

D. The conditions which need to be controls and the variable to be tested in the experiment:

☆☆☆

Exchange your homework sheet with someone else and have them answer the following:

1. Are the four parts described clearly? (2 pts each, 8 pts max.)

part A	YES	NO
part B	YES	NO
part C	YES	NO
part D	YES	NO

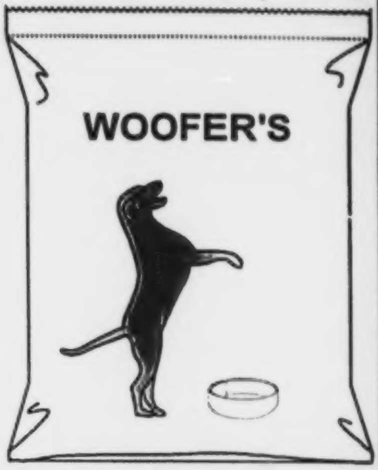
2. Is the hypothesis stated using “if...then”? (1 pt)	YES	NO
3. Is there only one variable in the hypothesis? (1 pt)	YES	NO
4. Is there a control in the experiment? (1 pt)	YES	NO

Peer reviewer name:____________________
Total Possible Points = 11 **TOTAL POINTS**______

Week 6 / Day 27 **Name:**______________________

Homework Sheet Key

Homework: Clues: Scientific Method, "Brainy Bits & Bytes," pp. 62-64. (95: "Brainy Bits & Bytes," pp. 52-54.)



Summarize the puppy food experiment by describing each of the following:

A. The question to be investigated:
(DO PUPPIES WHO EAT *FOOD MARKET'S BEST* GAIN AS MUCH WEIGHT AS PUPPIES WHO EAT *WOOFER'S*?)

B. The observations made:
(HOW MUCH WEIGHT THE PUPPIES GAIN EVERY TEN DAYS)

C. The hypothesis:
(IF *FOOD MARKET'S BEST* IS AS HEALTHY FOR PUPPIES AS *WOOFER'S*, THEN PUPPIES WHO EAT *FOOD MARKET'S BEST* WILL GAIN AS MUCH WEIGHT AS THOSE WHO EAT *WOOFER'S*.)

D. The conditions which need to be controls and the variable to be tested in the experiment:
(THREE OF THE SIX PUPPIES ARE CONTROL GROUP)
(VARIABLE IS THE *FOOD MARKET'S BEST* BRAND OF PUPPY FOOD)

☆☆

Exchange your homework sheet with someone else and have them answer the following:

1. Are the four parts described clearly? (2 pts each, 8 pts max.)

part A	**YES**	NO
part B	**YES**	NO
part C	**YES**	NO
part D	**YES**	NO

2. Is the hypothesis stated using "if...then"? (1 pt) **YES** NO

3. Is there only one variable in the hypothesis? (1 pt) **YES** NO

4. Is there a control in the experiment? (1 pt) **YES** NO

Peer reviewer name:____________________

Total Possible Points = 11 TOTAL POINTS_____

Week 6 / Day 29
Homework Sheet

Name:________________________

Homework: Clues: Scientific Method, "Solution or Solid," p. 66. (95: "Solution or Solid," p. 57.)

After reading "Solution or Solid," choose five liquids to freeze. Write down your liquids in the numbered spaces provided below. Next to each liquid you have selected, predict whether that particular liquid will or will not freeze. (1 pt each blank, total 5 pts)

	LIQUID	PREDICTION (freeze or not)	OBSERVATION (after 8 hours)
1.	______________________	________________	________________
2.	______________________	________________	________________
3.	______________________	________________	________________
4.	______________________	________________	________________
5.	______________________	________________	________________

Time liquids were put in freezer:_______. (1 pt)

Time liquids were taken out of freezer: ______. (1 pt)

1. **What happened to each liquid? Fill in the "OBSERVATIONS" COLUMN. (1/2 pt each, 2.5 pts total)**

2. **How many of your hypotheses were correct? _____ (1/2 pt each, 2.5 pts total)**

Total Possible Points = 12

TOTAL POINTS=_______

Week 6 / Day 29 **Name:**____________________
Homework Sheet Key

Homework: Clues: Scientific Method, "Solution or Solid," p. 66. (95: "Solution or Solid," p. 57.)

After reading "Solution or Solid," choose five liquids to freeze. Write down your liquids in the numbered spaces provided below. Next to each liquid you have selected, predict whether that particular liquid will or will not freeze. (1 pt each blank, total 5 pts)

	LIQUID	PREDICTION (freeze or not)	OBSERVATION (after 8 hours)
1.	_ (WATER)___________	__(WILL FREEZE)_	__(FROZEN)____
2.	_(ALCOHOL)_________	__(WON'T FREEZE)	__(NOT FROZEN)
3.	______________________	________________	________________
4.	______________________	________________	________________
5.	______________________	________________	________________

Time liquids were put in freezer:_______. (1 pt)
Time liquids were taken out of freezer: ______. (1 pt)

1. What happened to each liquid? Fill in the blank under "OBSERVATIONS" above (1/2 pt each, 2.5 pts total)

2. How many of your hypotheses were correct? _____ (1/2 pt each, 2.5 pts total)

Total Possible Points = 12 **TOTAL POINTS**_____

INTEGRATED SCIENCE 6
BLOCK 1

ASSESSMENT MATRIX

BLOCK OBJECTIVES	**BLOCK ASSESSMENT WKS 1-3**	**BLOCK ASSESSMENT WKS 4-6**
I. Science Process Skills		
A. Use all the senses to make observations.		
— describe how we use the senses to make observations	X	
— give examples of tools that are used to extend the senses	X	
— make qualitative and quantitative observations	X	
— use instruments to make and record metric measurement	X	
— understand that observations can lead to clues about the past, present, and future	X	X
— describe how clues offer information to archaeologists, paleontologists, astronomers, and forensic scientists	X	
B. Classification		
— classify things based on their characteristics and properties	X	X
— classify objects as being symmetrical or asymmetrical		X

BLOCK OBJECTIVES	BLOCK ASSESSMENT WKS 1-3	BLOCK ASSESSMENT WKS 4-6
— classify organisms based on their type of symmetry (radial or bilateral)		X
II. Scientific Method Use the strategies of the scientific method.		
— formulate a scientific question based on observations		X
— recognize what makes up a scientific inquiry		X
— recognize that experiments have variables and controls		X

WEEKS 4-6 (75 points) **NAME** ______________________

INTEGRATED SCIENCE 6 - BLOCK ASSESSMENT

For the past three weeks you have studied more about clues. Let's see what you remember.

1. Observe the artifact samples on display.

a. In a sentence describe one of the artifact samples you see. [RUBRIC: 3 points for complete description; 2 points for mostly complete description; 1 point partially complete description.]

b. List three different ways you could classify these artifact samples, using observable characteristics or properties. [RUBRIC: 2 points each for appropriate observable characteristics]

Characteristic/Property 1:

Characteristic/Property 2:

Characteristic/Property 3:

2. Give three examples of how artifacts/clues help us understand the past. (Be sure to use complete sentences.) [RUBRIC: 2 points each for acceptable answers; 1 point for partially acceptable answers.]

3. Look around the classroom. Identify 3 things that are asymmetric, 3 things with bilateral symmetry, and 3 things with radial symmetry. [RUBRIC: 1 point for every correct answer]

Asymmetric	Bilateral symmetry	Radial symmetry
a.	a.	a.
b.	b.	b.
c.	c.	c.

4. Explain to a younger child the difference between bilateral symmetry and radial symmetry. Give an example of each and explain why this form is an advantage for that particular organism. [RUBRIC: 3 points for correct answer; 2 points for mostly correct answer; 1 point partially correct answer.]

5. Suppose you are a reporter assigned to cover the travels of a hot dog through the digestive system. Report on the hot dog's trip and make sure to include the exciting events that take place in the mouth, esophagus, stomach, and small intestine. [RUBRIC: 2 points for each correct explanation; 1 point for partially correct explanations.]

6. You and your friend are arguing about which brand of gum keeps its flavor longest. You think that the flavor of your Green Gooey Gum lasts a lot longer than your friends Cherry Chew. Rather than fight about it, you've decided to use the scientific method to settle your disagreement. [RUBRIC: 5 points for correct answer, 3 points for mostly correct answer; 1 point for partially correct answer.]

a. What is the question you need to investigate?

b. What hypothesis will you test? [RUBRIC: 5 points for correct hypothesis in if/then form; 4 points for testable hypothesis not in if/then form; 3 points for mostly correct hypothesis in if/then form; 2 points for mostly correct hypothesis not in if/then form; 1 point for partially correct hypothesis.]

c. How will you test your hypothesis? [RUBRIC: 10 points for complete description; 5-9 points for mostly complete description; 1-4 points partially complete description.]

d. In your test, what conditions will always be the same (held constant)? [RUBRIC: 3 points for complete answer; 2 points for mostly complete answer; 1 point partially complete answer.]

e. What condition (variable) will you test? [RUBRIC: 2 points for correct answer; 1 point partially correct answer.]

7. Draw a asymmetric design and a symmetric design below. On the symmetric design identify the type of symmetry and draw in the line or lines of symmetry. [RUBRIC: 5 points for each design properly done and 2 points for identifying the line(s) of symmetry.]

The University of Alabama
Integrated Science 1997-98 Subscription Agreement

This Subscription Agreement is between the Center for Communication and Educational Technology (CCET) at The University of Alabama and the Subscribing School System. The subscriber agrees to adhere to all policies and regulations as set forth in this agreement or it may be canceled. Processing of this Subscription Agreement and payment for enrollment in the Integrated Science program should be conducted in accordance with local school system/board/district policies and procedures.

ENROLLMENT DEADLINE: **If agreement is received by April 30, 1997, we will take $100 off the price of each teacher.**

TECHNICAL REQUIREMENTS:	Classrooms must be equipped with a color television and a programmable VHS videocassette recorder. A 25-inch (or larger) television is highly recommended. Each teacher needs daily access to an IBM-compatible or Macintosh computer equipped with a printer, modem and phone line. All equipment must be ready when classes begin.
SHIPPING & PRINT MATERIALS:	CCET will ship all printed and video materials to the teacher or a central receiving office as requested by the school or system. The cost for any special mailing or handling requirements above and beyond those mentioned above will be paid for by the school, system, or board. If teachers do not have access to e-mail by October 1, 1997, any materials that are normally received on e-mail will be mailed to the teacher at an additional cost of $50 per teacher for the entire school year. All bound and unbound print materials are copyrighted by CCET and The University of Alabama's Board of Trustees. Unbound printed materials may only be photocopied by enrolled teachers in the amount needed for their students.
TELECASTS:	Telecasts are available on public television in the following states: AL, MS, NC, Radio Quebec and Palm Beach County ITFS System. Telecasts are also available via satellite through Telstar 401. If your state does not carry our program via public television and you do not have a satellite, telecasts are available on video tapes. Telecasts are copyrighted by CCET and The University of Alabama's Board of Trustees. The subscriber is authorized to receive the telecasts and to make videotape copies for each enrolled teacher as long as all videotape copies are destroyed after one year's use of the tapes. Use of the videotaped copy shall be limited to unedited "in house" use that includes a copyright notice.
PURCHASING TAPES:	The cost for each video tape is $10. If you return the tape to CCET to be recycled, the cost is $5 per tape. Each tape includes three 20 minute telecasts (enough for one week) for one grade level. The cost is $325 for the entire year for each grade level if you do not choose to recycle the tapes. The cost is $162.50 for the entire year for each grade level if you choose to recycle the tapes. One purchase order may be issued for tapes for the year. Telecasts on videotapes are copyrighted by CCET and The University of Alabama's Board of Trustees. The subscriber is authorized to make videotape copies for each enrolled teacher as long as all videotape copies are destroyed after one year's use of the tapes. Use of the videotaped copy shall be limited to unedited "in house" use that includes a copyright notice.

Please send subscription agreement to Kim Mitrook; University of Alabama/CCET; Box 870167; Tuscaloosa, AL 35487-0167; or Fax 205-348-0736. Phone: 1-800-477-8151

STUDENT HANDBOOKS: Students use handbooks as a supplement to the broadcasts and to complete homework assignments. The handbooks are an essential part of the curriculum. Student Handbooks are copyrighted by CCET and The University of Alabama's Board of Trustees. First year teachers receive 30 sets of student handbooks for their classroom. **Additional handbooks are $15.95 per set (includes four volumes) or $13.00 per set if 100 or more are ordered for a grade and delivered to one address.** Books should be ordered on the blue book order forms or via purchase order prior to the beginning of the school year. If you do not wish to order books, you can purchase a camera ready copy of the books for $40 per grade level for the entire year (this includes copies of all four volumes or $10 per volume). Systems who wish to print their own books need written permission from CCET.

SUGGESTIONS: INTEGRATED SCIENCE works best in classes with a maximum of 20 -30 students.

INSERVICE: **Teacher forms are enclosed in this subscription agreement**. Please note that teacher forms will not be accepted until CCET receives the subscription agreement. A calendar of summer workshop dates and teacher forms will be mailed to participating schools and teachers in January. Teachers will receive confirmation letters and detailed information about the summer workshop upon receipt of the subscription agreement and completed teacher forms. **The earlier an agreement is received, the greater the chance that teachers will obtain their first or second choice of dates.**

FIRST-YEAR TEACHERS: First-year teachers must attend a four day inservice session in the summer. Registration and opening remarks will be on Sunday night and inservice will finish not later than 5 p.m. Thursday.

RETURNING TEACHERS: Second year teachers are required to come to a one day session in the summer. Registration and opening remarks will be on Thursday night and inservice will finish not later than 5 p.m. Friday. Teachers who have completed 2 or more years of training are not required to attend inservice, although it is encouraged to attend at least every other year. Final determination for attending inservice after 3 years should be made by the school and/or system and subject to their inservice and certification requirements. Schools and systems that have inservice requirements above and beyond the Integrated Science requirements should notify their teachers of those requirements on receipt of this Subscription Agreement.

ENROLLMENT DEADLINE: **If agreement is received by April 30, 1997, we will take $100 off the price of each teacher.**

Please send subscription agreement to Kim Mitrook; University of Alabama/CCET; Box 870167; Tuscaloosa, AL 35487-0167; or Fax 205-348-0736. Phone: 1-800-477-8151

SCHOOL SYSTEM NAME: ____________________

NAME OF COUNTY: ____________________

TYPE OF SYSTEM: ☐ **COUNTY** ☐ **CITY** ☐ **PRIVATE**

SYSTEM ADDRESS: ____________________
(Street)

____
(City) (State) (Zip)

MAILING ADDRESS: ____________________
(if different) (P.O. Box)

____
(City) (State) (Zip)

SYSTEM PHONE: ____________________

SYSTEM FAX: ____________________

SUPERINTENDENT: ____________________

SYSTEM CONTACT: ____________________
(if different)

SYSTEM CONTACT TITLE: ____________________

CONTACT PHONE: ____________________

MEDIA SPECIALIST: ____________________

I certify that I have read this subscription agreement in its entirety. I will adhere to all policies and regulations as set forth in this agreement and accept fiduciary responsibility for all fees.

AUTHORIZED SIGNATURE: ____________________

TITLE: ____________________

DATE: ______/______/______

Separate sheets for each participating school are attached. **There are ____ school forms. Billing will be September 1, 1997**, unless a written request to change is approved by the CCET Budget Manager, Melanie Danner. A purchase order is preferred.

CANCELLATION: The removal of a teacher in the IS program must occur before August 15, 1997. Otherwise the school system subscribing teachers in the program will be responsible for payment. If the cancellation occurs before August 15th, all materials must be returned to The University of Alabama and any costs incurred will be billed.

Please send subscription agreement to Kim Mitrook; University of Alabama/CCET; Box 870167; Tuscaloosa, AL 35487-0167; or Fax 205-348-0736. Phone: 1-800-477-8151

PLEASE COMPLETE A SEPARATE PAGE FOR EACH SCHOOL

SCHOOL NAME: ____________________

MAILING ADDRESS: ____________________
(for materials)
(P.O.Box)
____
(City) (State) (Zip)

MAILING ADDRESS: ____________________
(for kits)
(Street)
____
(City) (State) (Zip)

TELEPHONE:____________________**FAX:**____________________

PRINCIPAL:____________________

SCHOOL CONTACT: ____________________

MEDIA SPECIALIST:____________________

ESTIMATED NUMBER OF STUDENTS TO BE ENROLLED IN INTEGRATED SCIENCE AT THIS SCHOOL____

ESTIMATED PERCENTAGE OF MINORITY STUDENTS TO BE ENROLLED IN INTEGRATED SCIENCE AT THIS SCHOOL______ (Optional Question)

IS YOUR SCHOOL ON BLOCK SCHEDULING? YES ☐ NO ☐

INTEGRATED SCIENCE WILL BE OFFERED IN: ____ 6th ____ 7th ____ 8th

If a teacher's name is not available at this time, write TBA. However, please provide this information as soon as possible. Inservice Registration forms are included in this envelope. For each teacher who is participating, the following information is needed: teacher name; Integrated Science grade; number of years completed teaching Integrated Science; billing package. Please be sure to list an individual's name for every Integrated Science grade which s/he will teach.

Teacher Name	Grade	Year in IS	Billing Package	If Replacement Teacher, name IS teacher to be replaced
(Sample: John Doe)	6	2	RT-2	Jane Doe

Please send subscription agreement to Kim Mitrook; University of Alabama/CCET; Box 870167; Tuscaloosa, AL 35487-0167; or Fax 205-348-0736. Phone: 1-800-477-8151

INTEGRATED SCIENCE FEES FOR THE 1997-98 SCHOOL YEAR

The cost to attend a regional session is slightly higher due to the extra cost for staff travel and facilities outside The University of Alabama.

If agreement received by April 30, 1997, we will take $100 off the price of each teacher.

☞ FIRST-YEAR TEACHER ATTENDING TUSCALOOSA SESSION (T-1) $ 1,850.00

☞ FIRST-YEAR TEACHER ATTENDING REGIONAL SESSION (R-1) $ 2,100.00

- Four Day Inservice (includes lodging, meals, supplies, and instructional services)
- Science Laboratory Kit
- Curriculum Materials
- Electronic Mail Software (Prepaid Site License Fees and Toll-free Network Access)
- Classroom Set of Student Handbooks (30 copies of each volume)
- $150 Stipend (sent to teachers so they can buy perishables)
- Tuition

NOTE: For a first year teacher who teaches more than one grade of IS, the cost for each additional grade is $ 1,200.00 **(not subject to discount)** and includes:

■ Curriculum Materials ■ Classroom Set of Student Handbooks
■ Tuition ■ $150 Stipend for Perishables ■ Network Access ■ Science Laboratory Kit

If agreement received by April 30, 1997, we will take $100 off the price of each teacher.

☞ SECOND-YEAR TEACHER ATTENDING TUSCALOOSA SESSION: (T-2) $ 1,250.00

☞ SECOND-YEAR TEACHER ATTENDING REGIONAL SESSION: (R-2) $ 1,400.00

- One Day Inservice (includes lodging, meals, supplies, and instructional services)
- Science Laboratory Kit
- Updated Curriculum Materials
- Updated Electronic Mail Software (Prepaid Site License Fees and Toll-free Network Access)
- Tuition
- $150 Stipend (sent to teachers so they can buy perishables)
- Class Set Replacements for Revised Handbooks (30 copies)

NOTE: For a second-year teacher who teaches more than one grade of IS, the cost for each additional grade is $ 750.00 **(not subject to discount)** and includes:

■ Science Lab Kit ■ Updated Curriculum Materials ■ $150 Stipend for Perishables
■ Network Access ■ Class Set Replacements for Revised Handbooks (30 copies) ■ Tuition

If agreement received by April 30, 1997, we will take $100 off the price of each teacher.

OPTIONAL CHOICES FOR TEACHERS WHO HAVE COMPLETED 2 YEARS OF TRAINING:

☞ Affiliate Teacher Package Attending Tuscaloosa Session: (T-3) $ 600.00

☞ Affiliate Teacher Package Attending Regional Session: (R-3) $ 750.00

- One Day Inservice (includes lodging, meals, supplies, and instructional services)
- Updated Curriculum Materials
- $150 Stipend (sent to teachers to buy perishables)
- Updated Electronic Mail Software (Prepaid Site License Fees and Toll-free Network Access)

☞ Affiliate Teacher Package Without Inservice Training: (A-3) $ 475.00

- Updated Curriculum Materials
- $150 Stipend (sent to teachers to buy perishables)
- Updated Electronic Mail Software (Prepaid Site License Fees and Toll-free Network Access)

Please send subscription agreement to Kim Mitrook; University of Alabama/CCET; Box 870167; Tuscaloosa, AL 35487-0167; or Fax 205-348-0736. Phone: 1-800-477-8151

If agreement received by April 30, 1997, we will take $100 off the price of each teacher on curriculum materials only.

OPTIONAL CHOICES FOR TEACHERS WHO HAVE COMPLETED 2 YEARS OF TRAINING OR MORE:

☞ Integrated Science A LA' CARTE

- Updated Curriculum Materials (M-3) $ 225.00
- Updated Electronic Mail Software (N-3) $ 100.00

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☞ NEW TEACHER REPLACING A SECOND-YEAR TEACHER ATTENDING TUSCALOOSA SESSION: (RT-2) $ 1,550.00

☞ NEW TEACHER REPLACING A SECOND-YEAR TEACHER ATTENDING REGIONAL SESSION: (RR-2) $ 1,800.00

- Four Day Inservice (includes lodging, meals, supplies, and instructional services)
- Science Laboratory Kit
- Updated Curriculum Materials
- Updated Electronic Mail Software (Prepaid Site License Fees and Toll-free Network Access)
- Tuition
- $150 Stipend (sent to teachers so they can buy perishables)
- Class Set Replacements for Revised Handbooks (30 copies)

NOTE: For a second-year teacher who teaches more than one grade of IS, the cost for each additional grade is $ 750.00 **(not subject to discount)** and includes:

■ Science Lab Kit ■ Updated Curriculum Materials ■ $150 Stipend for Perishables
■ Network Access ■ Class Set Replacements for Revised Handbooks (30 copies) ■ Tuition

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☞ NEW TEACHER REPLACING A THIRD-YEAR OR MORE TEACHER ATTENDING TUSCALOOSA SESSION: (RT-3) $ 925.00

☞ NEW TEACHER REPLACING A THIRD-YEAR OR MORE TEACHER ATTENDING REGIONAL SESSION: (RR-3) $ 1,075.00

- Four Day Inservice (includes lodging, meals, supplies, and instruction services)
- Updated Curriculum Materials
- $150 Stipend (sent to teachers to buy perishables)
- Updated Electronic Mail Software (Prepaid Site License Fees and Toll-free Network Access)

If agreement received by April 30, 1997, we will take $100 off the price of each administrator attending the optional full week of inservice or optional two day inservice.

☞ ADMINISTRATOR ATTENDING FOUR DAY TUSCALOOSA SESSION: (A-F) $ 550.00

- Four Day Inservice (includes lodging, meals, supplies, and instruction services)

☞ ADMINISTRATOR ATTENDING TWO-DAY RETURNING TEACHER WORKSHOP: (A-T) $ 250.00

- One Day Inservice (includes room/board, supplies, and instructional services)

☞ ELECTRONIC MAIL FOR ADMINISTRATORS (E-A) $ 100.00

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Why can't American kids keep pace with other kids in the industrialized world when it comes to science?

Trick question. They can! But not without radical reform in our schools.

Normally, reform takes decades, but Integrated Science offers schools a way to change now, thanks to the resources and training it is providing to middle school science teachers. Using satellite technology and public television, Integrated Science brings a whole new way of learning science to your students today.

The Integrated Science Curriculum

Integrated Science classes are available for sixth-, seventh-, and eighth-grade students. The classes show students how their world works, beginning with familiar things like classifying fingerprints. The curriculum is a spiraling sequence of well-integrated lessons in biology, physics, chemistry, and earth/space science. Because the basic sciences are introduced simultaneously, students will see how they fit together in a larger body of knowledge. They will also learn that science can help them with the problems and issues that concern them individually.

> ***"As a scientist and educator, I'm excited about what Integrated Science is doing for middle school students. With this project, the University has demonstrated what higher education, the K-12 community, and corporate sponsors can do to infuse new interest in and excitement about science."***
>
> *Roger Sayers, President*
> *The University of Alabama*

A Real Partnership for Progress

Integrated Science is a unique public-private partnership developed, supported, and directed by The University of Alabama. Three private-sector organizations — Alabama Power Foundation, Russell Corporation, and AmSouth Bancorporation — have made multi-year commitments that are helping to underwrite the cost of curriculum development. Following the lead of Alabama Public Television, several public television networks are contributing airtime. In other states, there has been widespread installation of satellite dishes and ITF systems. School districts throughout the country are using U.S. Department of Education Eisenhower Mathematics and Science Program funds to support their teachers' participation in this partnership.

The state departments of education in Alabama, Florida, Georgia, Mississippi, and North Carolina are also sponsoring pilot projects within their respective states. In most states, local schools have found additional funding help through small grant programs and local businesses. Each of these contributions, whether large or small, has played a critical role in expanding and strengthening the partnership.

The American Association for the Advancement of Science (AAAS) and the National Science Teachers' Association (NSTA) have both received support for their work developing new core content curriculum guides from the National Science Foundation (NSF) and the U.S. Department of Education. In line with the recommendations of these national bodies, Integrated Science believes that:

- All science disciplines should be taught to students every year.
- Concepts from biology, chemistry, physics, and earth/space science should be integrated around a set of topics that introduce the concrete before the abstract.
- Because less is more ... increased emphasis can be placed on fewer concepts. Integrated Science embraces the idea of spaced learning in which an idea is introduced and then spiraled to again and again.
- Heterogeneous cooperative learning groups focusing on hands-on activities bring enjoyment and better comprehension in addition to preparing students for future working relationships.
- Students need a chance to relate science to their everyday lives by examining its practical applications and relevance to societal issues.

> ***"After 25 years of teaching middle school science, I was looking for a 'shot in the arm' to get students excited about science. I found what I was looking for in Integrated Science. Students can't wait to get to class and see what will be explored. This program is the future for science!"***
>
> *RoseAnn Verheyen, IS 7*
> *Gulf Middle School*
> *New Port Richey, Florida*

The Integrated Science Classroom

In each Integrated Science middle school classroom, learning and enjoying science is a daily quest. With the support of our outstanding production team, for 20 minutes, three times a week, each Integrated Science on-air instructor — working in the field, talking with special guests, or using the sophisticated technology available in our studios — introduces science concepts. These telecasts are delivered via satellite and can also be seen on public television networks in many states and Quebec, Canada.

Using correlated curriculum materials developed by the Integrated Science team, teachers conduct demonstrations and lead their classes in hands-on activities and discussions that extend the understanding of concepts in the telecasts. Making use of the materials provided in their Integrated Science kits, classroom teachers guide their students in recapping what they've seen, developing and testing hypotheses, and drawing conclusions.

Before they begin using the Integrated Science program, participating teachers receive a week of training. All participating teachers become part of an electronic mail network supported by the University that allows them to share information, evaluations, and questions with each other and the Integrated Science staff. The network allows for the immediate delivery of timely material — from course registration information to assessments of student performance.

Working with the Institute for Communication Research (ICR) and the SouthEastern Regional Vision for Education (SERVE), we are monitoring the impact of Integrated Science on teachers and students.

The Integrated Science Connection

Integrated Science was created to help schools move to the forefront of science reform in America and more than 500 schools have already done so. The financial support of corporations, state and local governments, and national foundations is making this exciting science program available to your students.

For more information on any aspect of the Integrated Science program or the national reform movement that inspired it, contact Dr. Larry Rainey, project director, or Kim Mitrook, assistant director for marketing of the University of Alabama Center for Communication and Educational Technology, at this address:

The University of Alabama
Center for Communication
and Educational Technology
Box 870167
Tuscaloosa, AL 35487-0167
(800) 477-8151 or (205) 348-0430

"What you see today is an important start on changing the quality of education in the state."

Elmer Harris, CEO
Alabama Power Company

"Integrated Science has made a great impact on my students and the community as well. Not only has the failure rate dropped from around 17 percent to less than 5 percent, businesses and industries are excited about the program and getting involved."

Brad Holley, Assistant Principal
LaFayette High School
Chambers County, Alabama

"Integrated Science provides all the necessary tools that empower a teacher to teach science the way it ought to be taught. Ask any student at Fort Middle School what's their favorite subject and their reply is 'SCIENCE!'"

Kerri Deal, IS 8
Fort Middle School
Columbus, Georgia

"The Integrated Science program has generated more parent, student, and community interest in science teaching than any other program I have ever seen. We have used IS in regular, advanced, and gifted science classes and seen average increases on skills tests of up to 20 points per class — many individual students have gone up as much as 50 points during the year. I would recommend the program to any school for any level of student; everyone can be successful with Integrated Science."

Roxanne Miller, IS 6
Arvida Middle School
Miami, Florida

"Integrated Science has changed my classroom into a place that students want to come to and don't want to leave."

Jimmy Stanley, IS 7 and IS 8
Bankhead Middle School
Cordova, Alabama

"We can foster and fuel a positive change in science instruction by broadcasting it statewide to homes and schools."

Judy Stone, Executive Director
Alabama Public Television

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80%
of
Eighth-Graders
Want Nothing More
To Do With Science

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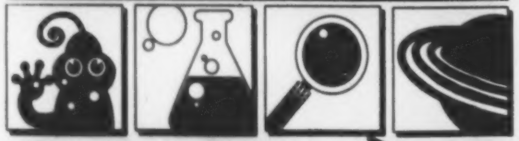
Wants Nothing Less
Than A
180°
Turnaround

INTEGRATED



SCIENCE

Supporting the National Reform Effort
in Secondary School Science

VOLUME
1

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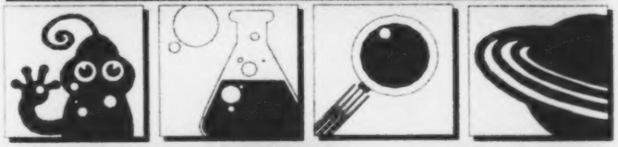

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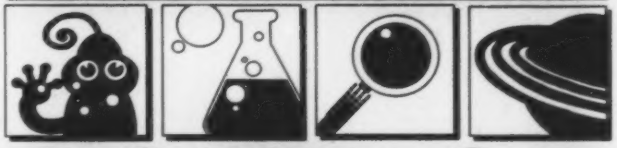

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STUDENT HANDBOOK
VOLUME 1

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ACKNOWLEDGEMENTS

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August 15, 1996

Dear Students:

On behalf of the Integrated Science team, I would like to welcome you to the sixth grade. This year will hold lots of firsts for you: for many of you it will be your first year of middle school, perhaps in a new building. You may also be taking a daily science class for the first time. We want to make sure you enjoy it, and that's where this class comes in. It's called Integrated Science, and you'll be doing a great deal more than just reading a book and taking tests. You'll be part of a program that includes telecasts (videos) made just for you. Your class will view these telecasts three times a week, and will actually interact with the teachers and other science professionals who create the videos here at the University of Alabama. We'll have puzzles, games, and some surprises that will make science fun. You'll also be involved in lots of hands-on activities that show you how science is really done. This handbook will help you keep up with the telecasts and activities, and it also contains lots of interesting and unusual facts that go along with what you're studying. At the end of each chapter there are homework assignments that we think you will find interesting — you may even wish to involve your parents and friends!

I hope this letter has made you curious about Integrated Science. If it has, chances are you'll be a great student because curiosity is a good way to begin studying science. Remember that we're always interested in what you think, so write and give us your opinion of Integrated Science. Good luck in class, and have fun discovering the incredible world of science.

Sincerely,

Larry Rainey

Larry Rainey, Ph.D.
Director, CCET

The University of Alabama
Box 870167
Tuscaloosa, AL 35487-0167

Integrated Science . . . you'll be involved in lots of hands-on activities that show you how science is really done.

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HOW WILL IT WORK?

Integrated Science 6: One Plan - Three Parts

Part 1: The Telecast

Ms. Cannon will be the lead instructor for the telecast portion of this course. She will introduce you to the important ideas and concepts related to each topic you study. Her own teaching experience and academic expertise are supported and expanded by the other members of our curriculum development team. Throughout the year, she will invite many people who study, teach, and do science to share their experiences with you during the telecasts.

The team specializing in telecast production includes graphic artists and videographers, as well as field and studio producers. Many of the telecasts feature segments created outside of our studio, which we hope you will enjoy and learn from at the same time.

Part II: The Classroom

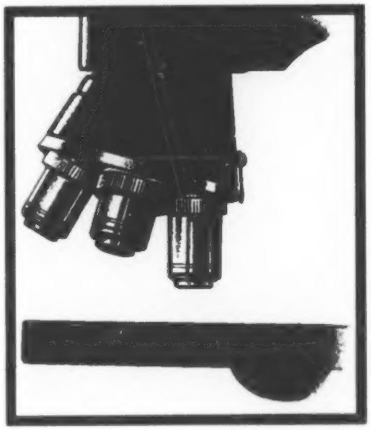
The real action takes place in the classroom under the direction of your classroom teacher. On the days you watch a telecast, you may also do a mini-activity, or your teacher may present a short demonstration that illustrates the concept being studied. You and your classmates will discuss and investigate a variety of science ideas.

Your classroom teacher is a very special person: someone who has already invested a lot of time and energy in this new class. He or she is the key to both your success and enjoyment in science this year. Your classroom teacher will be in touch with us daily, via our electronic bulletin board. When you have a special question, ask your teacher to send it to us. Your classroom teacher is responsible for grades, and you can make that part of his or her job easy by turning in all of your assignments on time.

Part III: Student Handbook

This is the first volume of the Integrated Science 6 student handbooks. Handbooks include lots of background information, interesting tidbits, and your homework assignments. Homework exercises are found at the end of each chapter. Your teacher will tell you which ones to complete and when they are due. Reading the handbooks will help you remember what you have learned in class, and the various homework assignments should provide opportunities for improving your science skills while having fun. Be prepared — when they see what you are doing, your family may decide that science is so much fun that they want to learn about it, too.

Some fascinating information awaits you in the **Fun Facts** and **Sad Facts. Think About It** and **Brainy Bits and Bytes** reading sections include information that relates to what you are studying as well as additional background information we hope you find fun and interesting. When it is time to review for tests, reread these sections along with your class notes. To learn more about something that interests you, look for additional resources at the library or a museum. A good science sleuth never objects to digging into books for the facts, so we have included a reading list on page 56.



Think About It

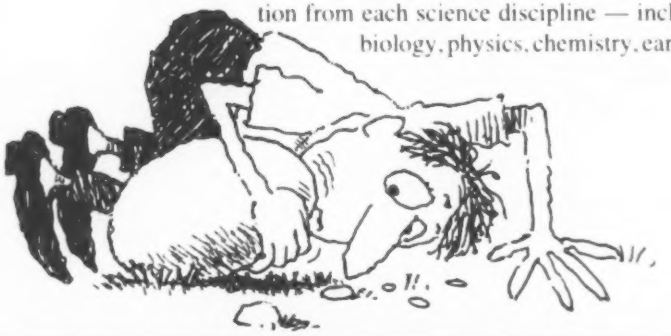
Think of this book as a "Handbook for Science Sleuths." A ***sleuth*** is a detective and ***to sleuth*** is to discover or search for something — in this case, science. What do we mean by science? Science is all the facts and information we know or learn about the universe as well as the methods used to obtain this knowledge.

Science is a way of understanding the world.

Identifying things by studying or observing them is an important part of the scientist's job. Hopefully, many of you will choose a career in science because you find it so interesting. But, even if you don't become a scientist, throughout life *everyone* must use science to help them understand and make sense of daily events and community problems.

All the science disciplines are interconnected.

Sleuthing will introduce you to information from each science discipline — including biology, physics, chemistry, earth and space science. Integrated Science's goal is to show that all the science areas relate to each of the topics we study. That part of our job is easy because all scientists use some of the same methods. Who are scientists? They are people just like you, who enjoy asking questions. They have their own way of searching for answers — what is known as the ***scientific method.***



The scientific method is a process that begins with making observations. Scientists observe both things and events. Their observations lead them to ask questions such as: Why does this happen? Why doesn't that happen? Why does this object look this way? What would happen if ... ?

Making observations and asking questions are important parts of the scientific process.

To be a good observer, you need to use all your senses. Many people think observing is just seeing things, but sight is only one of the five senses. Each of our senses allows us to make a different type of observation — to study a different ***property***, or ***characteristic***, of a thing.

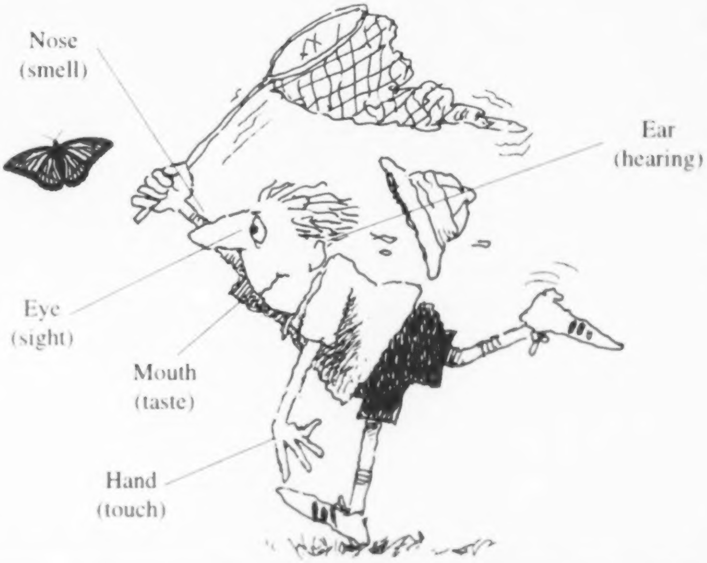
Whenever you read about how scientists work, the importance of making good observations is emphasized. We make an observation whenever we use one of our senses to gather information — and we do that all the time. Our eyes, ears, nose, tongue, and skin are the basic survival tools that nature gives us. Each of these body parts controls a particular sense and contributes to our ability to understand what is happening around us.

> **Your eyes provide the sense of *sight*, your tongue the sense of *taste*, your ears the sense of *hearing*, your nose the sense of *smell*, and your skin the sense of *touch*.**

Our senses allow us to react to both pleasant and harmful conditions. And we don't have to go to school or do anything special to make them work. After all, babies use their senses to discover the world even before they learn to walk and talk. They recognize the sound of their mother's voice, the touch of their father's hand, the scent of milk, patterns of light, and much more. In fact, because babies use their senses to investigate everything around them, we have to be sure they are placed in a safe and protected environment. Otherwise, they might taste something poisonous or touch something that is too hot.

Perhaps you are wondering how the sensory process works? One of your sensory organs detects a change or ***stimulus*** in the environment. The stimulus may be a difference in temperature or light. It could be related to pressure (sound or touch), or the chemical environment (smell and taste). The sense organ which has been stimulated sends a signal, or ***impulse***, to your central nervous system (which includes the brain and spinal cord). After the message is processed, the appropriate ***response*** or signal goes out to your muscles and limbs, and you react accordingly.

For example, if you bite into a rotten apple, the taste buds on your tongue detect the bad taste and send this information through the sensory nerves to your brain. It responds by sending another message to your mouth and throat, and you automatically spit the bad apple out. The whole process takes less than a second! The same speedy response would occur if you burned or injured yourself. You react to pain very quickly, sometimes even before you are aware of the pain or its source.

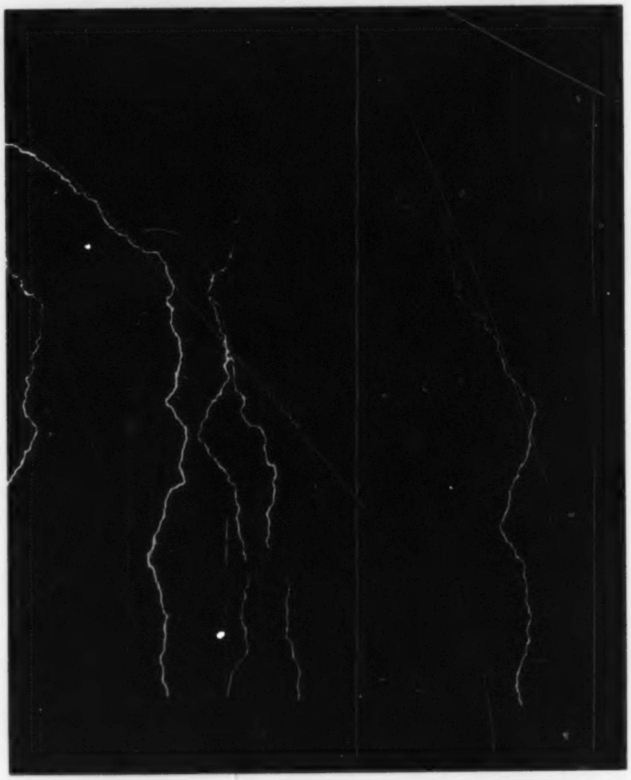


BRAINY BITS & BYTES

BOOM!

It's close to nine p.m. when an enormous noise makes you drop the IS6 handbook you're reading and dive under the bed. As flashes of light fill the room, penetrating even to your hiding place, your eyes blink shut in fear. It takes a few seconds before your brain processes all the messages flooding in from your senses, but finally you realize that the danger you are reacting to is only a thunderstorm. As you crawl out from under your bed, you wonder how your body reacted so quickly. Certainly, if you'd actually taken the time to think, you wouldn't have dived under your bed — not with the kind of junk you've thrown under there lately.

Well, you can thank your ***nervous system*** for the quick response. Your nervous system is the action control center for your entire body. It transmits and processes messages about your surroundings from your five senses; controls the way you react to these messages; and controls the way all the parts of your body function together. The nervous system is composed of many parts which work together to do different jobs.



Here's how the nervous system worked in the situation we just described: The loud, unexpected boom of thunder was a change in external conditions — a ***stimulus.*** Your ears detected the change and sent a message to your brain to tell it that a loud, short sound had been detected. When your brain received the message, it interpreted the noise as a potential danger and sent an urgent message to your body's muscles saying, "Move quickly and get me out of here!" Your muscles received the message and moved you under the bed. All of this happened before you really had time to think about what you were doing.

This type of nervous system response helps us to act appropriately in an emergency situation. Have you ever watched the evening news when a reporter interviewed someone who had performed a heroic deed — perhaps pulling a person from a burning building or lifting up a car that had

BANG!

pinned down a child? The reporter asks, "What happened?", and the heroine or hero replies, "I reacted so quickly, I really don't remember."

Usually, messages from our sense organs travel along the spinal cord on their way to the brain. In emergency situations, the nervous system can act without consulting the brain first. For instance, if you place your hand on a hot stove, the skin sends an "Ouch! Hot!" message to the spinal cord by way of a sensory nerve. Nerve cells inside the spinal cord transfer this emergency message directly to nerves in your hand's muscles. In what we call a ***reflex action***, your hand jerks back from the stove. An instant later, when the message reaches your brain, you feel pain!

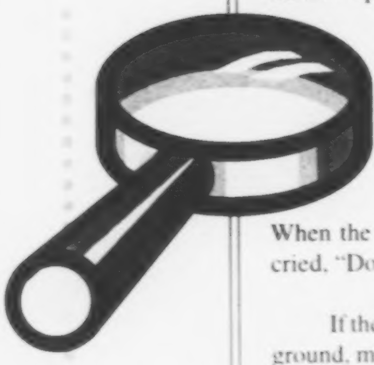
The ***nerve cells*** or ***neurons*** that are part of your nervous system are constantly providing you with information about your surroundings and keeping you out of danger. They also respond to internal changes. For example, nerve cells inside your body send hunger and thirst messages to your nervous system. When these messages reach your brain, you react by looking for food and drink. Other cells send messages about pain from headaches, stomach aches, sore throats, and other aches to different parts of the brain so that you know when you are sick. Still others sense changes in muscle tension and position, and thus help you stand upright. Because your nervous system coordinates your actions, it is often the key to your survival.

funfact

Did you know that your brain is being fooled every time you watch a movie? It's true. A motion picture is actually a series of thousands of still pictures projected one after another on a screen. Each picture has the subject in a slightly different position than the one before it. The images are shown in such a fast series, about 30 pictures a second, that the brain blends them together and perceives the subject as moving — but it really isn't.

The high-tech movies you watch today have come a long way from the first motion pictures made years ago. Back then, images on the screen were slower (there were fewer pictures per second), and they seemed to flicker across the screen. Because of that, people referred to these early films not as "movies," but as "flickers."

It's a riddle . . .



In 1870, a father and son were working on their ranch in Montana when a group of cattle bandits appeared. After a brief gunfight, the bandits escaped with the family's small herd. The father was badly wounded and unable to move, but the son, who was only shot once, rode into town to get the doctor. The boy barely made it through the office door before collapsing. When the nurse saw him, she jumped up and cried, "Doctor, come quickly, it's your son!"

If the boy's father is lying wounded on the ground, miles away, how can this be? To solve this old riddle, you have to read it without making any assumptions (taking things for granted). This sounds easy enough, but it's actually very hard. Your brain always tries to take thinking "shortcuts" by making assumptions based on your past experience and knowledge. These assumptions then influence how your brain uses the messages it receives from your five senses and how it interprets information. The whole process is called ***perception***. Sometimes your perceptions are incorrect, even though they seem right.

In the case of the riddle, when you saw the word "doctor," your brain quickly assumed "man." This perception is misleading, because there were also women doctors, even in frontier times. One such pioneer doctor was a woman named Sofie Herzog. She removed so many bullets from gun-fighting cowboys that she made a necklace out of them. Now do you know the answer to the riddle? Riddles fool us because they intentionally lead our brain into making incorrect perceptions. ***Optical illusions***, on the other hand, fool us because our brain perceives what looks obvious as correct even when it isn't. This is the way perception works. . .

SENSES —— MESSAGE

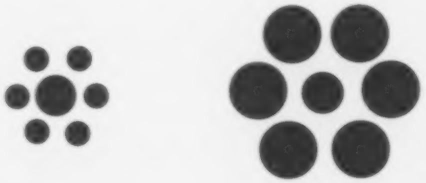
|

BRAIN —— INTERPRETATION

|

PERCEPTION

For example, look at the two patterns below. Which pattern has the largest circle in its center? Obviously, the circle on the left is bigger than the one on the right — or is it? If



SLEUTH ALERT

you take a ruler and measure the size of each of these circles, you will see that they are exactly the same size. So, why do they appear to be different?

Again, it's a matter of perception. Our senses send the brain a message to let it know that there is a certain size circle out there. Now, the way our brain interprets this message is a matter of perception. A visual trick like the one above works because the clues in the picture have managed to fool the brain's interpretation — falsifying its perception. In the pattern on the left, the center circle appears larger because it is surrounded by smaller circles.

Since most of us perceive things the same way, it can be difficult to change false perceptions. For example, when vaccines were first developed, many people were afraid to have their children vaccinated because the vaccines came from cows. People thought that vaccinated children might behave like cows. Eventually, this false perception was overcome when the vaccines proved to be safe.

Through the years, tools have been created to increase the range of our senses. Instruments like telescopes, microscopes, hearing aids, X-ray machines, and computers have allowed mankind to see and hear things that could otherwise not be sensed. Yet, nothing is perfect, and even with the help of technology, it is still possible to have false perceptions.

DID YOU KNOW?

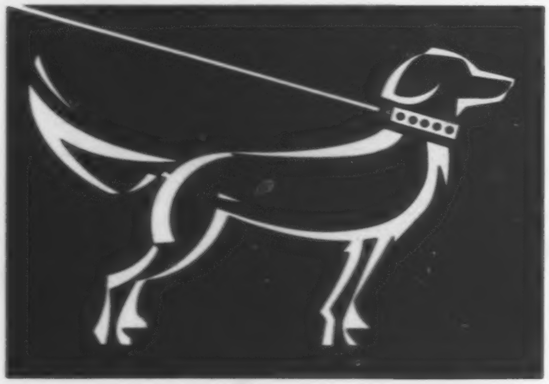
Humans lag woefully behind many other animals when it comes to using their sense organs. Take the domesticated dog — not only do dogs have a better sense of hearing than people, they also have a far better sense of smell. One breed that is particularly famous for its sniffing ability is the bloodhound. Bloodhounds were originally bred for hunting and tracking and have carried this tradition into modern times.

Today, many police officers use bloodhounds to help them find missing persons and escaped criminals. Bloodhounds are also capable of sniffing out the flammable material used by arsonists to start fires. And while any dog can follow a fresh trail, bloodhounds are the champs when it comes to following a "cold" trail. A cold trail is one that is several hours old, and thus has lost most of its scent. Bloodhounds often put their noses directly on the ground to follow such trails. A famous bloodhound from Kentucky once successfully tracked down an arsonist who had fled from the scene 105 hours earlier. With that ability, it's no wonder that this same hound had more than 600 arrests to its credit.

Other animals are known for their incredibly keen eyesight. Many people are under the impression that human vision comes very close to perfection, but some bird species have much better eyesight. That's why the words "hawk-eyed" or "eagle-eyed" are often used to describe excellent human eyesight. Hawks and other birds of prey have vision that is eight times sharper than humans. A hawk can spot a crouching rabbit more than two kilometers away. Furthermore, hawks can focus on two objects at the same time.

Humans rank a little better in the hearing department because the range of frequencies they hear is fairly wide. But using ears for hearing may seem dull after you read about some other methods. Many insects make up for not hearing with their sense of touch. Cockroaches, for example, have sensors on their legs that are so keen they can detect the tiny vibrations produced by other roaches walking nearby. Male mosquitoes recognize females of their species by picking up the sound frequency of their beating wings. They do this with the help of highly sensitive hairs on their antennae.

While certain animals have one or two specially developed senses, it should be noted that they lack the more complete range of senses that humans and other advanced mammals possess. Much of this has to do with the needs of these animals. Hawks don't need a very keen nose — their eyesight allows them to spot prey rather than smell it. And roaches don't need super eyesight to find crumbs and water on the floor. Humans, on the other hand, must function in so many different situations that they need to be able to hear, see, taste, smell, and feel things. Interestingly, people who have gone blind or lost their hearing will often learn to develop one of their remaining senses more fully in order to make up for the loss. A blind person, for example, may recognize other people by the sound of their footsteps, their scent, or their handshake.

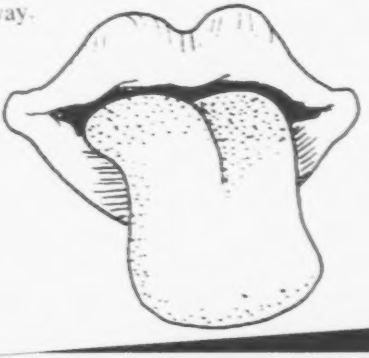


NOT ONLY DO DOGS HAVE A BETTER SENSE OF HEARING THAN PEOPLE, THEY ALSO HAVE A FAR BETTER SENSE OF SMELL.

funfact

If you thought those bumps on your tongue were taste buds, guess again. Your taste buds actually line the sides of these bumps, but they are so tiny that you need a strong magnifying glass to see them. Here's another surprising fact. There are no taste buds located in the middle of your tongue. (If you want to check out this fact, try placing lemon juice or salt on the middle of your tongue ... you will not taste it.)

Your tongue has about 10,000 taste buds. But your taste buds only live for about ten days, so your body is always creating new ones. How many taste buds you actually have depends on your age. When you were born, you had very few — which may explain why infants can eat baby food! Children and young adults like you have lots of taste buds, but as you grow older you will have fewer and fewer. So, now you can tell your parents there's a scientific reason why you don't like all the foods they enjoy — but they'll probably want you to eat your vegetables anyway.



• HOMEWORK •

How Keen are Your Senses?

The following experiments each involve one of your five senses. Choose one or more to try at home. Write a short explanation of your results. Be sure to state what you expected would happen and whether or not the actual results matched your expectations.

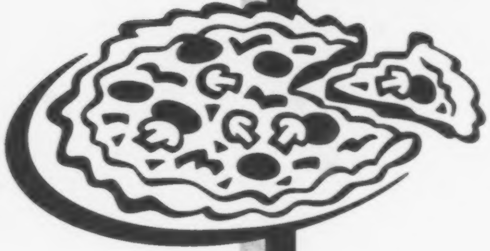
TOUCH — Cross your first and second fingers. Run the tips of your crossed fingers up and down a pencil, along the bridge of your nose, and over a smooth marble. Describe how it felt. Did anything surprise you?

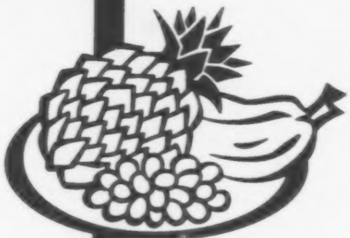
TASTE — Use a clean wooden spoon or popsicle stick to test your taste buds. Press the wooden spoon or stick against different parts of your tongue — the sides, the back, and the tip. Where did you taste wood, something else, or nothing?

SMELL — A few grains of coffee is all you need for this test. Hold your nose so you cannot smell the coffee at all, then place the coffee grains in your mouth and chew them. What do they taste like? Now, stop holding your nose. Do the coffee grains have a different taste?

HEARING — If you have a large sea shell, press the opening of it to your ear and listen. Do you hear the roar of the ocean? Now, take an empty jar or glass and hold the open end against your ear. What do you hear now?

SIGHT — Close one eye and look at a single object. While looking at this object, gently push the side of your open eyelid. What seems to be happening to the object?





Menu Magic

Whether it's our taste buds or a matter of perception, we all prefer some foods over others. Think of the foods you like — what characteristics make them taste good to you? Try writing about one of your favorite foods. In the first column, list all the observations you can make about your food item. In the next column, name the property that each observation describes. In the last column, list the sense used to make the observation.

Example:

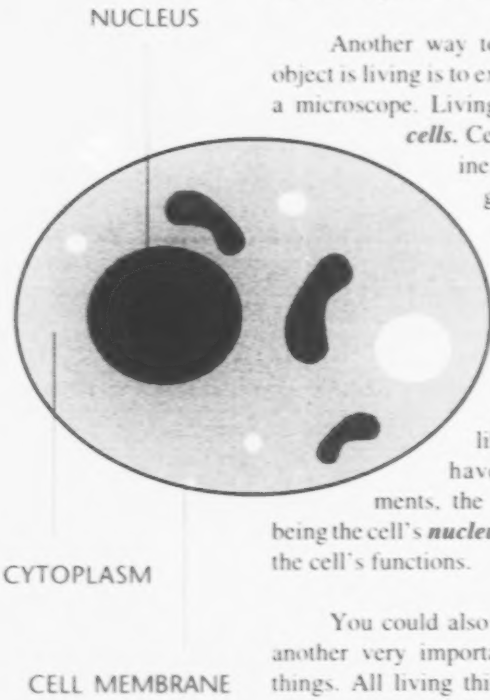
Strawberry Ice Cream

OBSERVATIONS	PROPERTY	SENSE
sweet	flavor	taste
pink	color	sight
smooth	texture	sight
cold	temperature	touch
berry scent	odor	smell

Think About It

If you want to become a science sleuth you must learn to recognize the characteristics of ***living things***. When you are making observations, look at an object's ***form*** or shape. Many living things have shapes that are easy to recognize. But, while there's no mistaking a banana for a cactus or a puppy — non-living objects present more of a challenge. Rocks, for example, come in all sorts of irregular shapes and sizes. Sometimes an object's form is all it takes to determine whether it is living or non-living, but usually more clues are needed.

Another way to tell whether or not an object is living is to examine its ***structure*** under a microscope. Living things are made up of ***cells.*** Cells are fairly easy to examine. If you were to investigate their composition, you would find that all cells have a liquid called ***cytoplasm***. This "cell liquid" contains proteins, fats, sugars, starches, vitamins, steroids, and nucleic acids like DNA. Many cells also have specialized compartments, the most important of these being the cell's ***nucleus*** because it controls all of the cell's functions.



You could also look for ***water,*** which is another very important component of living things. All living things require water in one form or another. Water makes up most of an organism's mass, so it follows that the chemical reactions which make life possible actually occur in water. These chemical reactions are known as ***metabolism.*** Metabolism includes processes such as digestion (the breaking up of foods) and respiration (the burning of these foods for energy). Metabolism in plants includes the chemical reactions of photosynthesis. In ***photosynthesis*** plants make food from carbon dioxide and water using the sun's energy. Photosynthesis is important because it produces food for the plant and both oxygen and food for animals.

Your observations should include measuring for growth. Chemical reactions taking place within living things allow them to manufacture cells and repair damaged parts. This process is controlled by a chemical called ***DNA***. Humans, dogs, trees, flowers, bacteria, and all other living things carry DNA in their cells. DNA contains the codes for tissue growth and repair, determines how large an organism will become, what color and sex it will be, how much hair it will have, and other physical attributes. Some type of movement is also a characteristic of living things. Animals and plants can both move. In fact, the cytoplasm inside the cells of living things moves, too — but of course you need a microscope to see that.

Another characteristic of living things is their ability to make other organisms just like themselves. This ability is known as ***reproduction.*** While the fact that life comes from life

continued

Think About It, *continued*

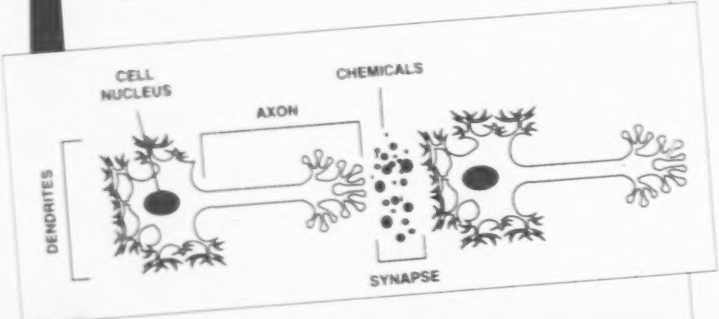
may seem obvious today, until the 17th century there were many people who believed that some forms of life came from non-living things. They thought, for example, that frogs came from rainstorms, fleas came from sand and flies came from rotten meat.

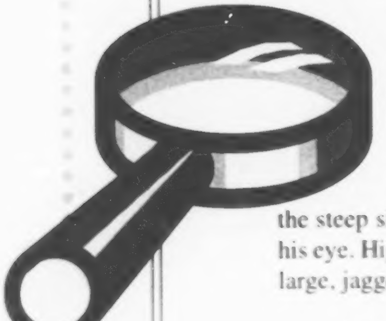
Yet another way to determine whether something is alive or not is to see if it ***responds*** to change in its environment. Responses can be short- or long-term. The movement of an organism away from some type of stimulus (like diving under the bed when you are scared) is an example of a short-term response. We have to study the history of an organism to learn about its long-term responses, which are known as ***adaptations***.

funfact

Each cell in an organism has its own job to do. In the last chapter, when we discussed how our senses operate, we learned that animals have special cells called neurons, or nerve cells, which allow different parts of the body to communicate with each other. Neurons are long, thin cells that act like electrical wires by transmitting messages throughout the body. Each neuron has a cell body with thread-like fibers called dendrites at one end and a long fiber called an axon at the other end.

Neurons are lined up in the body so that the axon of one cell is close to the dendrites of another. Messages enter a cell through its dendrites and are carried along by electrical impulses. When the message reaches the end of the axon, certain chemicals are released that move across the gap, or synapse, between the axon and the next cell's dendrites. The dendrites pick up the chemical message and the process repeats itself. In this way, messages are passed from neuron to neuron throughout the body.





Do you know how long people have inhabited the North American continent? Until the 1920's, the oldest evidence suggested that they had been present for three to five thousand years. That idea was disproved in 1926, thanks in part to the keen observations of a cowboy named George McJunkin. McJunkin was riding his horse along a trail in New Mexico, looking for lost cattle. As he scanned the steep sides of a gulch, something caught his eye. High up on the canyon wall, a line of large, jagged bones stuck out.

At first McJunkin thought he was looking at cattle bones. But that didn't make sense. The bones were buried so deeply that McJunkin decided they belonged to an animal that had died a long time ago. Since cattle weren't native to America, he wondered what type of animal it was. He pulled out his pocket knife, and began poking around. McJunkin extracted a few pieces of chipped flint from amongst the bones. They were obviously man-made spear points, very different from the Apache spear points and arrowheads he was used to finding. His curiosity raised, McJunkin took the flint pieces into town. Everyone who saw his find told him that the site ought to be examined by professionals.

As it turned out, they were right. McJunkin's find led to the discovery that humans had been living in North America for over 10,000 years — much longer than was previously thought. The bones were those of a long extinct bison, and the flint spearpoints were those of early native Americans who had ambushed them. One curious cowboy's lucky observation led to what is perhaps the most important discovery in 20th century American archeology. While not all observations produce such significant discoveries, this story highlights the fact that being a good observer can pay off.

Observation is crucial to gaining a better understanding of our world. That is why scientists stress observing and asking questions as the first steps in performing a scientific investigation. We observe things every time we use our senses to gather information. Sometimes it's easy to make observations. Take a book, for example. You can tell just by looking at it and picking it up whether it has a hard or soft cover, what color the cover is, and whether it has many pages or just a few. You may be able to tell whether it is old or new by looking at how worn the pages are, or even by smelling the pages.

continued

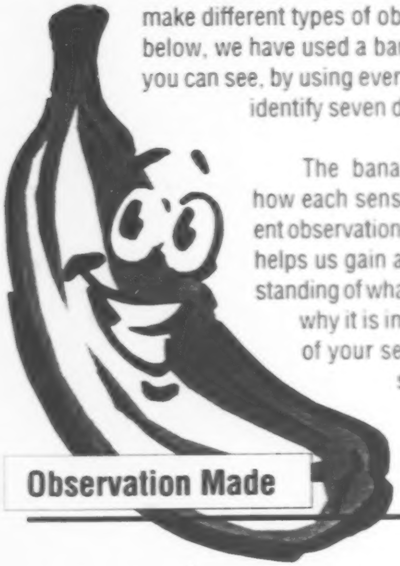
SLEUTH ALERT

SLEUTH ALERT, *continued*

On the other hand, some observations are more difficult. If you open the book and look inside at a color photograph of a flower, you may be able to say that it is a yellow rose. But if you were to take a magnifying glass and look at the rose, it wouldn't look solid yellow anymore. In fact, you would see that the rose is made up of countless small dots in yellow, red, blue, and black. Many colored pictures are produced by a four-colored printing process. So, we should also note that a little knowledge is another way to improve your powers of observation.

If we look at the book and decide that it's old because the pages are yellow and it smells musty, we are making an inference. An ***inference*** is an explanation or interpretation of our observations. Let's use a lunch bag as another example. You may notice that it is much heavier on one side than the other, and that the heavier side is also slightly rounded. If you drop the bag on the floor, it lands with a solid-sounding "thud." If you pick the bag up and smell it, you smell apple. You have now used four of your five senses to make observations about your lunch bag. Taken together, these observations help you infer that there is an apple in there — probably a bruised one!

BRAINY BITS & BYTES



With practice, we can learn to observe many of an object's characteristics. We can note its shape and size as well as its color and texture. Each of our senses allows us to make different types of observations. In the chart below, we have used a banana as an example. As you can see, by using every sense we were able to identify seven different characteristics.

The banana example illustrates how each sense helps us make different observations. Using all of our senses helps us gain a more complete understanding of what we are studying. That's why it is important to use as many of your senses as possible in describing something.

In the chart, all the statements about bananas used qualitative words. When we add the ending *-ative* to the words quantity and quality, we are describing a certain type of characteristic. ***Qualitative*** observations use adjectives and adverbs to describe things. The banana was soft, sweet, yellow, and pointed. Its peel was firm and layered. All of these are qualitative words. To help you remember the meaning of qualitative, think of the word quality (or trait).

The other type of observations we make are ***quantitative***. These observations involve actual numbers. For example, we could measure the size of this page and see that it is 21.6 cm x 21.6 cm. We could have actually measured the banana and given its length in centimeters. To remember the word quantitative, think of the word quantity (or the amount).

Observation Made	Sense Used	Characteristic Identified
Bananas are yellow in color.	sight	color
Bananas have firm, smooth skin.	touch	texture
Bananas have a sweet taste.	taste	flavor
Bananas make very little sound when you eat them.	hearing	structure
Bananas have a pleasant scent.	smell	scent
Bananas come to a point at the top.	sight	shape
Bananas are about the length of your foot.	sight	size

funfact

Picture yourself in distant space, doing battle with an enemy spaceship. Or imagine yourself several kilometers under the surface of the ocean exploring the depths in a one-man submarine. Or better yet, imagine yourself being chased by dinosaurs. Would you like to do all of these things without ever leaving home? Well, you can — all you need is virtual reality. If you think video games are fun, just wait until you get inside this!

Virtual reality (or VR) uses a high-power computer to trick your senses. When you put on a VR headset, the computer senses your movement and allows the graphic images to move along with you. The "magic wand" is the cable connection between the computer and the headset. It creates VR — the feeling that you are interacting with the computer image.

Virtual reality has many exciting possibilities. Medical students using VR scalpels will be able to practice surgical techniques. Astronauts can use VR to take simulated spacewalks. Soon, Hollywood production companies will make VR movies — allowing you to help slay the monster or land on Mars. Virtual reality's ability to give the user the illusion of reality is very exciting. VR will also be a wonderful way for students to learn new things. Imagine, for example, wanting to learn about whale migration. With a VR headset you could swim down the coast of California with the humpbacks!

THE MYSTERIOUS WORLD OF THE BASEMENT

Sight

dim light
three large jars of fig preserves
dark staircase
dusty shelves
two muddy shovels
stringy spider webs
one ancient coal furnace
three broken windows
old flower pots

Touch

rough feel of the wooden stair handrail
the brittleness of peeling paint
cold draft of air (5°C)
cool, smooth cement floor
two dozen hard, rusty nails

Sound

squeaks of two big rats
low roar of the furnace
rustling of moths
footsteps overhead

Taste

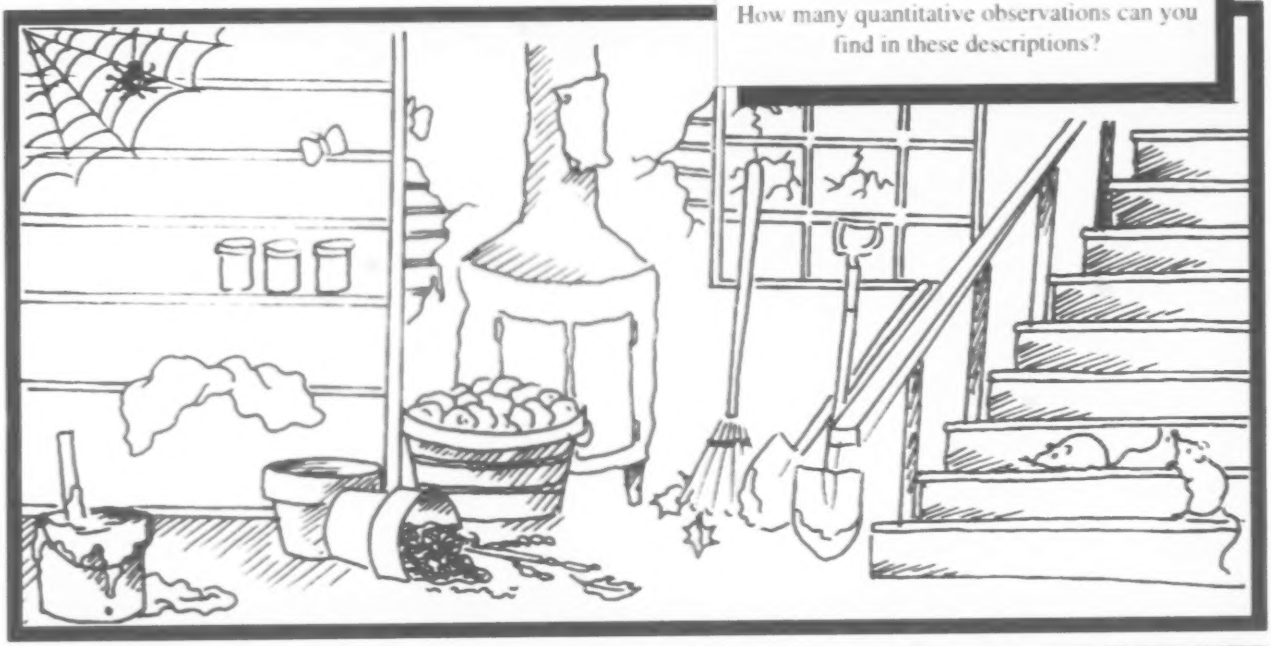
sweetness of the fig preserves
iron taste of water from the tap
tartness of an apple

Smell

musty smell of two old rags
lingering odor of paint
moldy leaves stuck to the rake
pungent aroma of a dozen rotting apples

JUST FOR FUN

How many quantitative observations can you find in these descriptions?



PICTURE THIS!

Here's a riddle: What is something everyone has, yet every single one is different? Want some more clues before you take a guess? This might help: The study of these unique things, or characteristics, is called ***dactyloscopy***. For at least 2,000 years, it has been recognized as an excellent way to identify humans and other creatures. Dactyloscopy can be used to identify a person even months after he or she has been around. Dactyloscopy uses a characteristic that is always unique (even in twins) and cannot be forged. That's why it can be used to identify criminals.

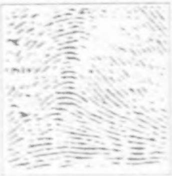
Have you figured it out? Dactyloscopy is the classification or examination of fingerprints. It is almost impossible to touch a solid object without leaving a fingerprint impression. That's because the skin on our fingertips has ridges. These ridges create a distinct and unique fingerprint pattern when the finger comes in contact with a solid object. We leave our prints on all types of surfaces because our fingertips are oily.

Using the Henry system developed by Sir Francis Galton in 1892, fingerprints can be classified into one of eight categories. Prints can be dusted and lifted off a surface as much as ten years after they were made. Classifying and matching up fingerprints has become an important FBI function. Today huge computers store the fingerprints of known criminals. Detectives can send fingerprints found at the scene of a crime for entry into these computers. Every month, the FBI helps solve more than 2,700 cases when they identify criminals-at-large by matching their prints with some of the 200 million fingerprints the agency already has on file.

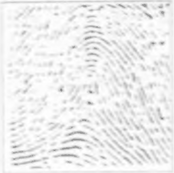
• HOMEWORK •

Can You Fudge a Fingerprint?

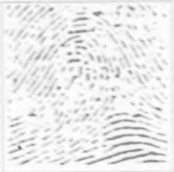
Now that you know something about fingerprints, this activity may get you interested in an FBI career. The illustrations below use the eight classifications known as the Henry System. Your assignment is to fingerprint yourself and at least two other members of your family. You can use ink, flour, pencil lead, or any substance that leaves an imprint on a piece of paper. Make a print of each of your fingers. Do they all fall into the same classification pattern? What about the prints of your family members — do everyone's fingerprints belong in the same category?



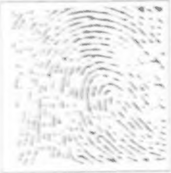
PLAIN ARCH



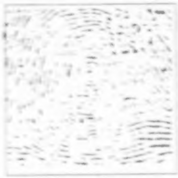
TENTED ARCH



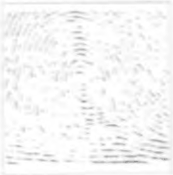
RADIAL LOOP



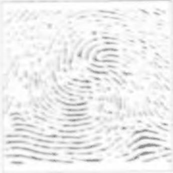
ULNAR LOOP



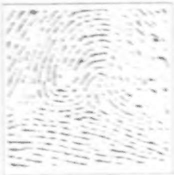
PLAIN WHORL



CENTRAL PACKET LOOP



DOUBLE LOOP



ACCIDENTAL

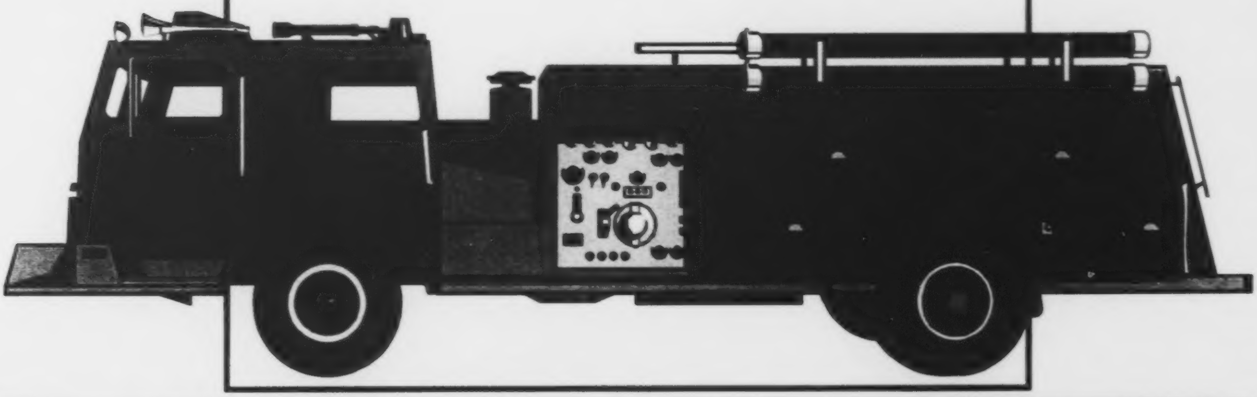
• HOMEWORK •

I Spy

Have you ever played the game "I Spy?" It's usually played in an automobile or on a train, and is a good way to keep from getting bored. One person says (for example) "I spy something brown, with four legs and a tail." The other people playing the game have to spot an object that fits the description. In this case, it could be a cow, a dog, or some other kind of animal. The first person to spot an object that "matches"gets to pose the next "I spy..." In addition to being fun, playing "I Spy" will improve your observation skills. Below is an exercise you can do for practice.

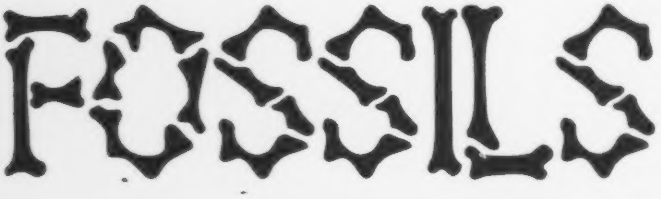
Think of five things you saw on your way home from school today. Write down a quantitative and qualitative word that describes each object. The chart below has a couple of examples. When you finish, try challenging some friends to a game of "I Spy."

Quantitative Word	**Qualitative Word**	**Thing You're Describing**
six	purple	flowers
two	red	fire trucks



Think About It

Looking for clues can help you learn about the past. Scientists who specialize in studying the past include archaeologists and paleontologists. ***Archaeologists*** are interested in how ancient people lived. They look for clues that tell them what types of food people ate, the shelters they built, the kinds of jobs they did, the types of animals that shared the land, the tools they used, and the art they produced. Archaeologists find their clues by excavating (digging) at locations, or sites, which they think people once inhabited.



Paleontologists are interested in all past life forms. Their training and work includes both biology and earth science. Their job is to examine the layers of the Earth for signs of life. Paleontologists are especially interested in ***fossils*** — the hardened remains of once-living plant and animal life. They use the information from fossils to piece together a picture of what life was like long ago. Paleontologists try to create a time line of events for the areas they investigate and then use them to compare development in different parts of the world. They have lots to study, since once-living plants and animals have left behind an enormous number of fossilized clues — from bones, to burrows, to bees preserved in amber.

But you don't have to be a trained scientist to be curious about the world. There are lots of amateur archaeologists and paleontologists. Have you ever looked for, or found, a fossil? If you have, give yourself a new title. Just tell your friends that you are an amateur paleontologist. (People are called "amateurs" when they do something just for the fun of it.) Often, amateurs discover an exciting new fossil area accidentally. If you take up this hobby, just think . . . you might be one of the lucky amateurs who make important discoveries.

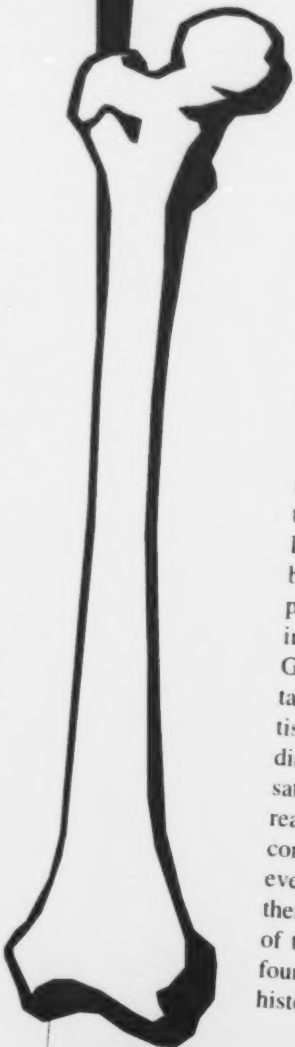
For professionals, though, collecting fossils can be a very complicated business. There are certain collecting methods and techniques that must be used. For example, when a large fossil specimen is discovered, paleontologists must be careful not to damage it. If the fossil is collected in a single lump, along with the surrounding earth materials, the following steps are taken to protect the fossil. First, the surface material above the fossil remains is cleaned off or removed to within 30 centimeters of the fossil.

During this part of the process, paleontologists use whatever tools are most convenient — from a bulldozer to a pick and shovel. It is

important to avoid excessive vibrations during this phase of the dig, but jackhammers and even dynamite are used occasionally. The secret is to dig deep down underneath the fossil and over an area wide enough to include all of it. As the dig proceeds, the last centimeters of rock are removed with light hand tools because fragile pieces of fossil may be found at any time. Picks, chisels, and even dental instruments are often used. The remaining block of earth is then carried back to the laboratory and cleaned.

So, if you think that the work of archaeologists and paleontologists sounds like fun, start investigating. But be sure you never destroy a site by taking fossil souvenirs. When that happens, the world loses valuable information about the past. In order to preserve fossil clues, it is important to contact professionals when a new site is found. That way, paleontologists and archaeologists can make a proper search of the area, collect evidence about the organisms that once lived there, analyze it, and share the information with others.

funfact



In 1822, a couple of amateur British paleontologists found the fossilized remains of what they thought was a large lizard — a dinosaur. They called their fossil find *Iguanodon* and tried to fit the fossilized bones together. Since parts of the skeleton were missing they were unsuccessful. But their discovery set off a dinosaur craze, and people began looking for and finding fossilized bones all over the place.

One of the earliest dinosaur reproductions was constructed in the 1850s. It was a model of an Iguanodon, and was created from blocks, cement, tiles, mortar, and paint. This huge model was placed inside London's Crystal Palace Gardens, and served as the dining table for a group of British scientists. The guests were seated in the dinosaur's abdomen, while the host sat in the dinosaur's head! Soon real dinosaur skeletons were being constructed by paleontologists who eventually figured out how to put them together. The fossil remains of the dinosaurs had finally been found, and the rest, as they say, is history.

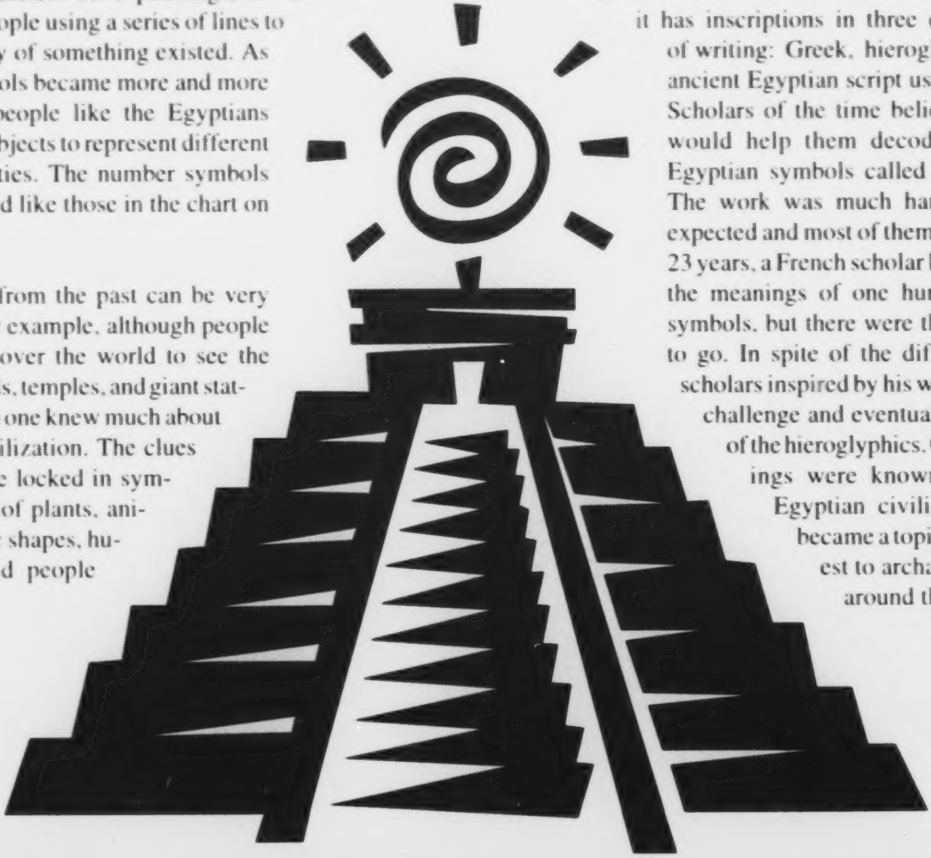
BRAINY BITS & BYTES

Pictures, words, and numbers can be used as ***symbols*** to represent an idea or object. While some symbols, like those found in cave paintings, help us understand the past, we also use symbols to help us communicate in the present.

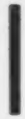
Anthropologists, people who study civilizations, believe that some of the first symbols developed were related to mathematics. Ancient cave paintings, for example, show people using a series of lines to show how many of something existed. As the use of symbols became more and more sophisticated, people like the Egyptians used common objects to represent different numeric quantities. The number symbols they used looked like those in the chart on the next page.

Symbols from the past can be very mysterious. For example, although people came from all over the world to see the ancient pyramids, temples, and giant statues of Egypt, no one knew much about this ancient civilization. The clues to the past were locked in symbolic drawings of plants, animals, geometric shapes, human heads, and people holding up their hands, squatting, and walking. Obviously, these symbols meant something. But no one knew what until a French soldier dug up a big, flat stone with writing on it — the same kind of mysterious writing that covered the tombs and statues.

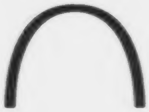
This object turned out to be one of the greatest historical treasures ever found. Called the Rosetta Stone, it has inscriptions in three different types of writing: Greek, hieroglyphic, and an ancient Egyptian script used in business. Scholars of the time believed the stone would help them decode the ancient Egyptian symbols called hieroglyphics. The work was much harder than they expected and most of them gave up. After 23 years, a French scholar had worked out the meanings of one hundred of these symbols, but there were thousands more to go. In spite of the difficulties, other scholars inspired by his work took up the challenge and eventually decoded all of the hieroglyphics. Once the meanings were known, the ancient Egyptian civilization quickly became a topic of great interest to archaeologists from around the world.



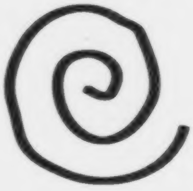
EGYPTIAN SYMBOLS



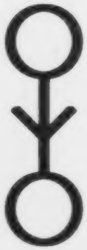
WAS THE SIGN FOR ONE.



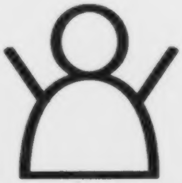
WAS THE SIGN FOR TEN.



WAS THE SIGN FOR A HUNDRED.



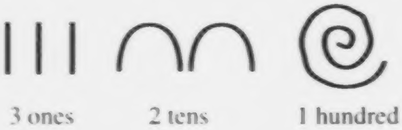
WAS THE SIGN FOR A THOUSAND.



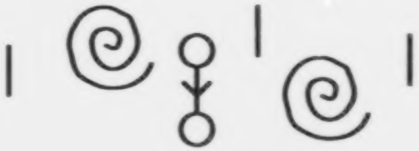
WAS THE SIGN FOR A MILLION.

The Egyptians wrote their numbers in the opposite direction from us. They went from right to left.

Example: 123 =



Sometimes their writing was really careless. Can you rearrange the folowing example to make 1,203?

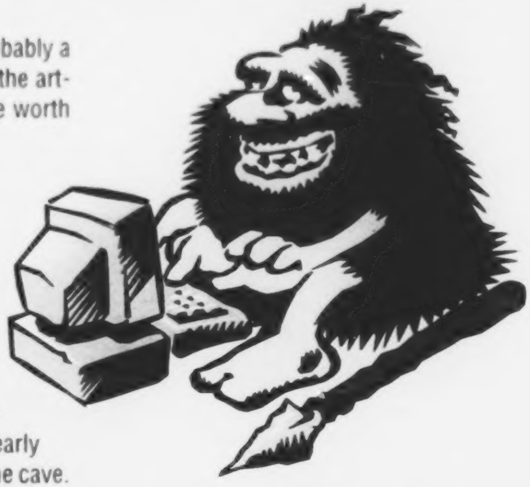


Yes, because each place value is a different symbol. So if you can group the symbols, you can figure out the number. Create a challenge for your group: write a mixed up number using the Egyptian symbols.

DID YOU KNOW?

Cave paintings have fascinated archaeologists for years. Most of these mysterious works of art were painted by people living thousands of years ago. Archaeologists, of course, are interested in learning how they were painted, and what the pictures mean. Samples taken from the caves show that prehistoric artists used coal, but not the kind of charcoal artists work with today. Instead, some believe that these ancient artists chewed the coal until it was the right consistency, and then spat it onto cave walls to create their works of art!

A few of today's artists have tried this procedure and found that it really works. They have recreated some of these beautifully detailed paintings by actually spitting chewed-up coal onto the surface of cave walls. The spitting must be a rapid-fire "rat-a-tat-tat" that takes a lot of practice. The artist has to chew lots of coal and mix it with saliva to get the right consistency. Chewing coal is probably a bad-tasting, unhealthy idea, but the artists seem to think the results are worth the effort.



Cave paintings offer the earliest recorded history of mankind's activities. In 1991, underwater archaeologist Jean Courtin found cave art that is 27,000 years old in a grotto near Marseilles, France. The pictures appeared to be hand stencils, drawn by the Paleolithic (early Stone Age) people who lived in the cave. When this cave was inhabited, the sea level was about ten meters lower than it is today. The sea level rose at the end of the last Ice Age (about 25,000 years ago) and flooded the lower half of the cave. Archaeologists believe that the flooding destroyed half of the cave art.

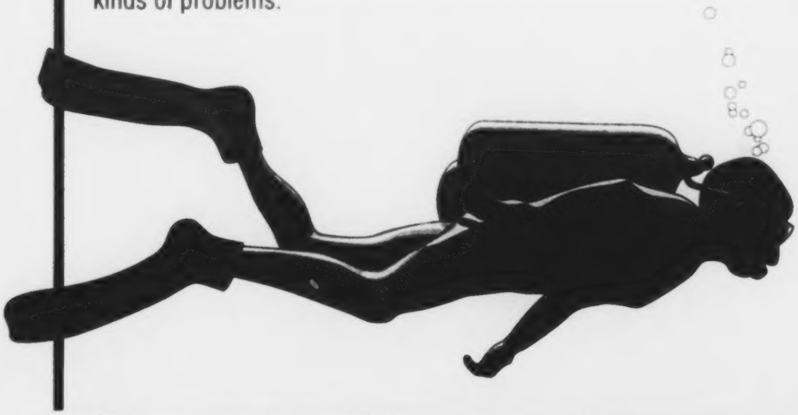
Around 17,000 BC, the cave inhabitants began painting and engraving geometric signs and animals. Horses, ibex, bison, deer, and seals are some of the animals found represented in paintings and engravings on the cave walls. The geometric patterns found in the cave include zigzag lines, dots, bars, and square shapes. Archaeologists are still trying to understand what these patterns and drawings meant to the people who put them there.

Since the only entrance to this cave is under water, doing research is difficult and dangerous. The French Ministry of Culture hopes to do a study which will help them decide whether it would be safe to bore a hole into the cave from the surface. In the meantime, the entrance to the grotto has been sealed in order to keep unauthorized divers out of this precious archeological treasure.

PICTURE THIS! PICTURE THIS! PICTURE

When you're thinking about all the important and priceless artifacts archaeologists have discovered on land, consider how many more there are to be found under water. Ships that sank centuries ago contain countless treasures within their wooden skeletons — all kinds of artifacts that unlock clues about the past. Like the remains of ancient villages buried deep below the ground, the artifacts of many cultures lie waiting under water. Excavation of these watery sites is the job of marine archaeologists.

Before diving gear was invented, archaeologists were very limited in what they could retrieve from oceans or lakes. If an archaeologist had reason to believe something important lay in a particular area of water, he would take a boat to the site and drag up what he could with nets. Unfortunately, this crude method damaged many of the artifacts that were retrieved. Finally, in the 1940s, modern, light-weight diving gear was invented, giving archaeologists the freedom to investigate underwater sites. Still, underwater archaeology is very difficult and presents all kinds of problems.

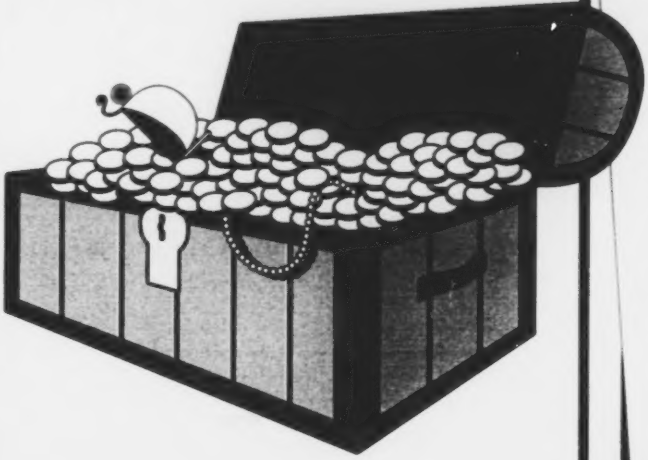


Even on dry land, archaeologists have to be careful not to damage fragile artifacts they dig up from the soil. Just imagine how much more difficult it is to do the same kind of work while submerged in cold, murky water. It may be difficult to see, or the diver's body may become numb with cold, so he or she can only work for limited amounts of time. When a diver locates artifacts, or a site to excavate, sediment must be removed from the area with a suction pump. Then the diver must use his or her bare hands to feel for things such as pieces of wood, pottery, bones, or coins. Before removing the artifacts, the diver may photograph or sketch them so that any changes in condition will be documented.

Having been in water for hundreds, or even thousands of years affects the chemistry of an artifact. So, once the objects are out of the water, great care is taken to preserve them. Most artifacts are damaged by water, but some materials such as wood are actually preserved better in water than out of it. Wood samples have a special value for archaeologists because the wood can be tested for age — making it easier to date any other artifacts found nearby. But wooden objects, such as spoons or containers, can rot if they dry out too suddenly. Even pottery fragments tend to crumble easily as they begin to dry after years under water. To prevent the destruc-

continued

PICTURE THIS! *continued*



tion of these artifacts, archaeologists often give them a chemical bath to strengthen them, or they may even keep them in bags of water.

The Earth's seas, oceans, and lakes keep marine archaeologists busy. While the oceans' depths have given up many treasures, there is much more awaiting discovery. Gold, jewels, and coins rest on the oceans' floors in rotting, watery chests, luring both archaeologists and treasure hunters. Even the remains of ancient villages have been found partially intact after being under water for thousands of years. But no one knows in advance whether they will find emeralds or eating utensils. And for every underwater site they work on, marine archaeologists spend weeks (or even months or years) planning and preparing the way they will excavate it. The work is difficult, often dangerous, and very expensive. Still, each successful excavation brings the world a few more priceless artifacts and more knowledge of the past.

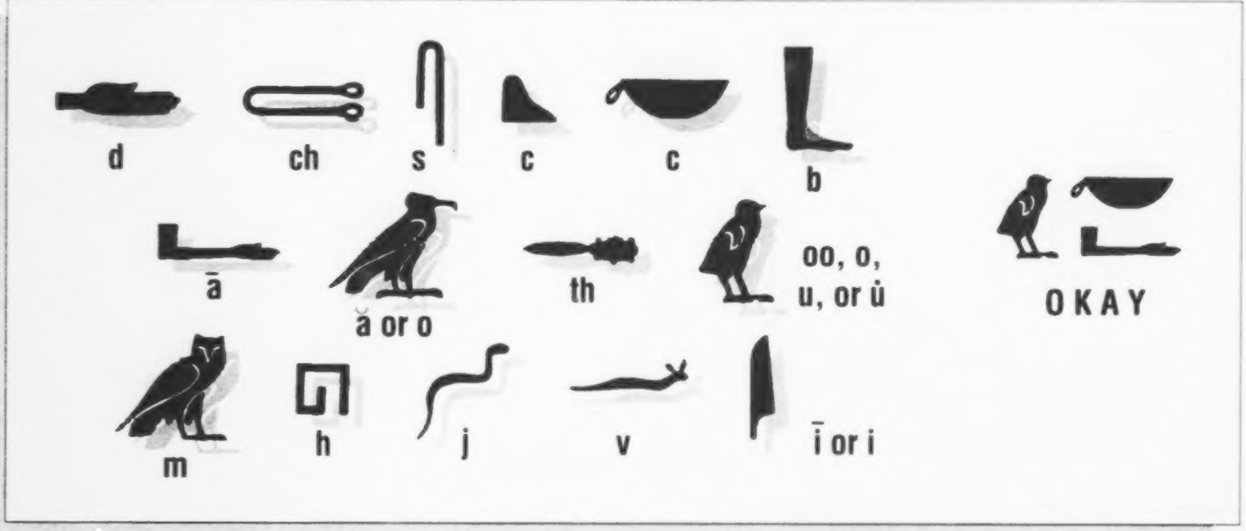
funfact

Science is constantly changing because of new discoveries and new ideas about old discoveries. Paleontologists, of course, continue to use fossil evidence to learn about many extinct species — including dinosaurs. Their work is often shared with the public through museum displays. Since 1915, for example, the American Museum of Natural History in New York City has displayed the Tyranno-saurus rex (T-rex) as standing erect on its hind legs with its tail dragging on the ground — looking a lot like Godzilla.

Recently, when paleontologists reexamined some fossilized footprints of a T-rex, they realized that there were no imprints of a tail dragging on the ground between the dinosaur's footprints. This new study made them realize that the dinosaur didn't drag its tail on the ground as it traveled. Instead, it appears that T-rex actually walked with its backbone parallel to the ground and its head pointed forward. The tail was held up in the air and acted as a counterbalance to the dinosaur's neck and head. So, based on this new look at some old evidence, the museum recently reassembled T-rex's skeleton. T-rex now poses as it probably spent much of its time — stalking its prey.

• HOMEWORK •

Secret Code ... Secret Message



Many early languages used pictures to represent different sounds. About 5,000 years ago, the Egyptians began to record their language this way. They left us lots of examples of their "hieroglyphs" or "sacred inscriptions" on the walls of the temples they built. But, for a long time, travelers to Egypt had no idea what these symbols meant since the Egyptians stopped using hieroglyphs 1,500 years ago. Around 1820, the code was broken and today we know the meaning of the pictographs shown here.

Your homework assignment is to design a secret code using pictures instead of letters or numbers. To start, draw a picture code for each letter of the alphabet. You may choose real or imaginary symbols, and you may either draw the pictures or cut out illustrations from newspapers and magazines. Once you have created a chart of your symbols, use them to write some secret messages. Bring the chart and three secret messages to class so you can share them with your group.

Think About It

How do archaeologists decide where to dig? With so much ground out there, they need a way to narrow down their choices. Usually something found on the ground invites them to begin exploring. It might be part of an old stone wall, bits of broken pottery, or an oddly shaped mound. Archaeologists also gather clues from folklore, legends, and myths and use them to locate likely historical sites. That was the method Heinrich Schliemann used when he made one of the most famous archaeological discoveries of all time.

As a boy, Schliemann was fascinated by the story told in the *Iliad*, a long Greek poem about the Battle of Troy written about 2,000 years ago. According to the poem, Troy was a large city in Asia Minor (present day Turkey), with walls so high and strong that attackers could not capture it. For ten years, Greek invaders fought to take over the city. Since they could not capture Troy by force, the Greeks came up with a plan to outwit the Trojans. They built a huge, hollow wooden horse and left it outside the city gate one night. The next morning, the Trojans found the horse, but saw no sign of their Greek enemies. Assuming that the Greeks had given up the battle and left the horse as a departing gift, they dragged it inside the gate. That night, Greek soldiers hiding in the hollow horse slipped out and captured the city.

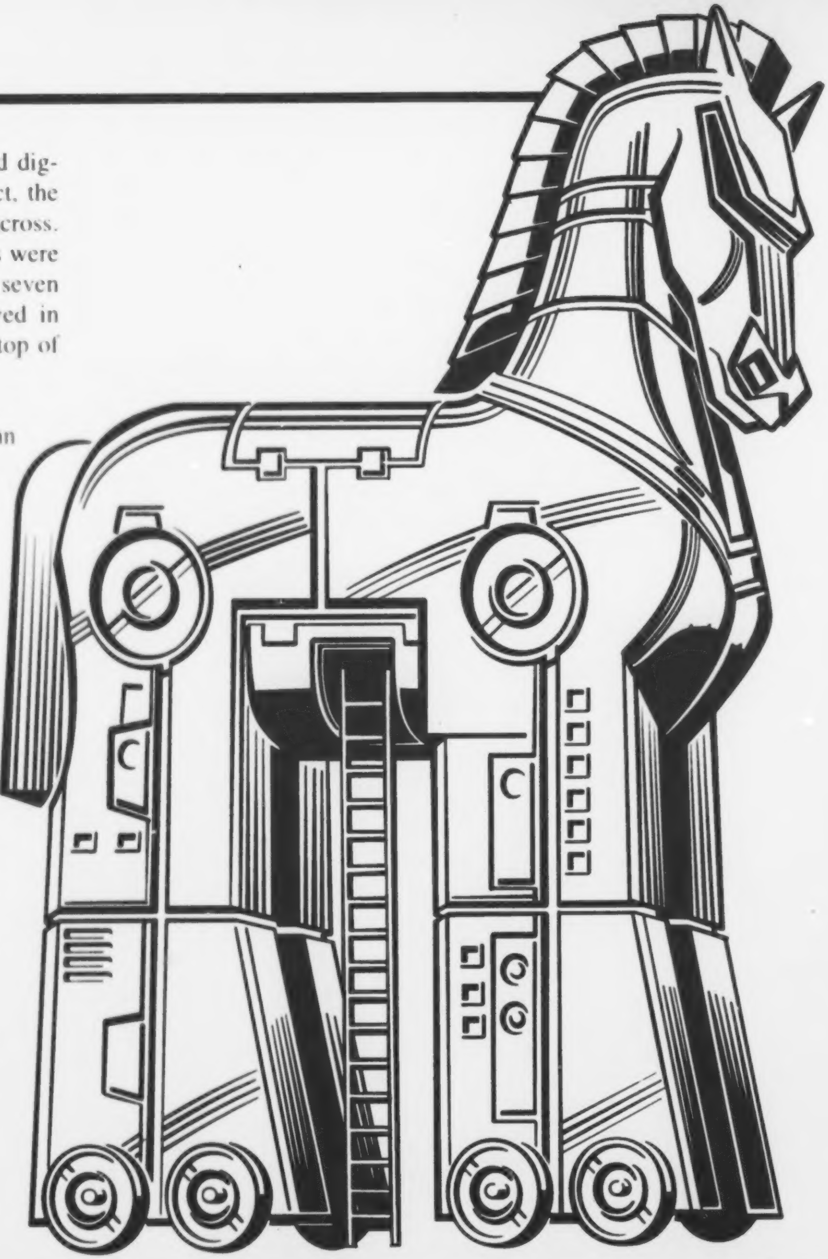
Although the story had been treated as a myth for hundreds of years, Schliemann thought it had really happened. When he became a rich man at the age of 46, he decided to use his new wealth to search for the city described in the *Illiad*. He consulted with other people who thought that Troy had really existed and they all advised him to begin his search on the coast of Asia Minor.

Schliemann searched for likely spots — areas that might have been home to the huge palaces and gigantic walls described in the *Iliad*. When he came to a hill called Hissarlik, he felt he had found the right place. Located close to the coast, the hill could have easily been reached by the Greek invaders. It was also large enough to have served as the foundation of a walled city. With permission from the Turkish government, Schliemann hired about a hundred laborers and began digging in April of 1870.

Soon after the dig began, the laborers found signs of a buried civilization. Schliemann wasn't sure that these were the ruins of Troy, so he instructed his workers to keep digging. Surprisingly, underneath that first city were the remains of another city and when they continued digging, they found yet another city. In fact, the lower they dug, the more ruins they came across. By the time Schliemann and his workers were done, they had uncovered the remains of seven cities. City after city had been destroyed in wars, and new cities had been built on top of the old, demolished ones.

But which one was Troy? Schliemann believed it was the second city from the bottom. The thick walls and large gate found at this level seemed to match the description in the *Iliad*. Although Schliemann died thinking he had identified Troy, he was wrong. He had indeed found the correct site, but three years after his death a city nearer the top was determined to be the real Troy.

Heinrich Schliemann's discovery revolutionized archaeology. Myths and legends were now seen as more than "just stories." Archaeologists began to treat them as likely sources of historical information. The increased attention given to myths and legends inspired many more important discoveries. Today, with lots of stories still to be investigated, we can probably expect that more archaeological finds in the future will result from these clues from the past.



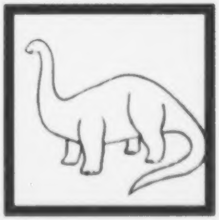
DID YOU KNOW?

You probably know that there are different kinds of dinosaurs, but do you know what their names mean? Dinosaur is a Greek word meaning terrible (*dino*) lizard (*sauros*). The term dinosaur was coined 150 years ago, when it was thought they were large reptiles. Today we know that dinosaurs really aren't lizards, but the "saurus" ending is still used to name most of the new dinosaur discoveries.

Some dinosaur names describe physical characteristics of the creatures. For example, *Spinosarus* was so named because it had very long spines on its back. *Anodontosaurus* got its name from the fact that it didn't have a single tooth in its mouth (*anodonto* = "without teeth"). Other dinosaur names describe where the animal's fossil was found. Can you guess the state in which *Arkanosaurus* was found? Still other dinosaurs are named in honor of important scientists. Among this group are *Parrosaurus* (named after a zoologist) and *Marshosaurus* (named after a paleontologist). Read the Dino Dictionary to find out more about the names and characteristics of some well-known dinosaurs.

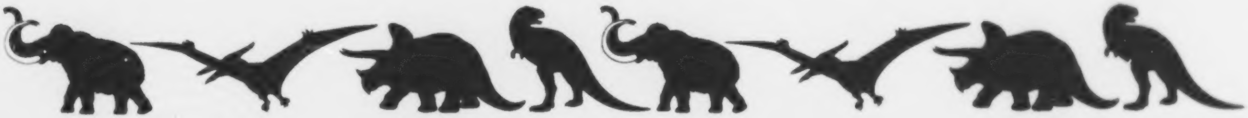
Dino Dictionary

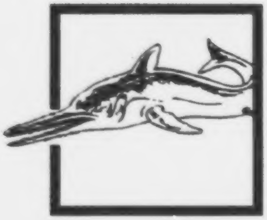
Allosaurus "Different Lizard" - because its vertebrae (back bones) were different from other dinosaurs. *Allosaurus* was a large meat-eating dinosaur of the Jurassic period. It reached 11 meters in length and weighed up to 3.6 metric tons. *Allosaurus* had sharp claws on its forelegs and its feet. Its large jaws were filled with sharp, pointed teeth.



Apatosaurus "Deceptive Lizard"- because scientists often confused it with other large, plant-eating dinosaurs. *Apatosaurus*, once known as *Brontosaurus*, lived during the Jurassic period. It reached 21 meters in length and weighed up to 27 metric tons. Its extremely long neck allowed it to bite off leaves and twigs from tree tops. Stones in *Apatosaurus'* stomach then ground and chewed the vegetation. Tracks have been found suggesting it traveled in herds.

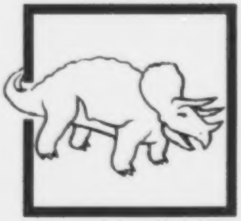
Diplodocus "Double Beam" - because it had double-beamed or "Y" shaped tail bones. *Diplodocus* was a plant-eating dinosaur of the Jurassic period. At 26 meters long and 18 metric tons, it was longer but lighter and thinner than *Apatosaurus*. *Diplodocus* spent much of its time in the water.



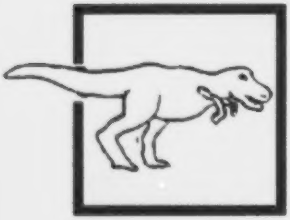


Icthyosaurus "Fish Lizard" - not a dinosaur at all but an ocean-going reptile. It had a streamlined, narrow body, usually from 1.5 to 3 meters long. Sometimes, however, they reached lengths of 12 meters. *Ichthyosaurs'* fish-like tails and flipper-like limbs made them excellent swimmers. Their long, narrow mouths were filled with sharp teeth.

Stegosaurus "Plated Lizard"- referring to the plates on its back. Another plant-eating dinosaur of the Jurassic, *Stegosaurus* grew to a length of 6 meters and a height of 2.5 meters. Two long rows of bony plates extended from its head to its tail, and several large, pointed spikes at the end of its tail provided it with protection.



Triceratops "Three-horned face" - because its face had three horns for defense. *Triceratops* was a plant-eating dinosaur of the late Cretaceous period. It grew about nine meters long. The last of the horn-faced dinosaurs, *Triceratops'* skull ended in a long, bony shield that protected its neck and shoulders.



Tyrannosaurus rex "Tyrant Lizard" - because of its great size and wicked teeth and claws. A meat-eating dinosaur of the Cretaceous period, *Tyrannosaurus* grew to a length of 15 meters and a height of 5 meters. It possessed huge jaws filled with sharp, curved teeth. *Tyrannosaurus'* arms were so short, it could not even scratch its chin.

BRAINY BITS & BYTES

Pretend you are a junior detective at the scene of a crime. You're looking for evidence, but there's not a fingerprint to be found. You're feeling kind of discouraged, but your boss (the chief detective) has found something he's very excited about. His evidence is a strand of hair which he carefully places in a plastic bag and labels.

"Why go to all this trouble?" you ask. "Is there any way that you can solve a crime and catch the criminal with a piece of hair?"

"Yes!" says the chief. "Looks like you skipped the DNA Testing 101 class." Since the chief wants you to be a good investigator, he tells you to go back to school for a crash course in this very important subject.

You find out there's a lot to learn. ***DNA*** (or deoxyribonucleic acid) is present in all organisms. It contains genetic information that is unique to each individual. DNA can be taken from hair, blood, or other parts of the body. Your DNA contains all the genetic information needed to make you (think of it as your body's blueprint). Each one of us has a different arrangement of DNA, so we are all unique. But, every cell in your body that has DNA (except the egg or sperm cells) has the exact same arrangement of DNA as every other cell. That means a scientist could examine DNA taken from one of your hair cells, a liver cell or a bone cell, and all the samples would be absolutely identical.

Through the years, scientists have used the knowledge they gained about DNA in a number of ways — from identifying criminals to finding out more about ancient organisms. DNA fingerprinting is a method that scientists use to compare DNA samples. This process involves taking a bit of DNA from the evidence (whether it's a hair or some body tissue), then chemically "cutting" or "chopping up" the DNA. These tiny bits of DNA are then placed into a solution and separated into bands by running an electric current through the solution. At this point the process has created an invisible pattern. After several more steps, an X-ray film is used to develop the pattern of light and dark bands, which look like the bar codes you see on items at a supermarket.

This is the DNA fingerprint, and it can be used in a number of ways. That single hair found by the detective at the scene of the crime can now be compared to the hair of a person suspected of committing the crime. Once the DNA tests are run, the two samples can be compared. If they match, the evidence can be used to help convict the suspect. Anything from a blood sample to a single strand of hair can be all the evidence you need to solve a crime, or even unlock a mystery related to an extinct species.

You also learn that these same DNA tests are helping scientists find out more about our past. Recently, newspapers reported that a graduate student at Montana State University's Museum of the Rockies isolated red blood cell samples from a 65-million-year-old fossil of *Tyrannosaurus rex*. Now the woman is trying to extract DNA from these blood cells in order to compare it to the DNA of present-day crocodiles and birds — the organisms thought to be the closest living relatives of dinosaurs. If they find that the DNA "fingerprints" are similar, that would support the hypothesis that crocodiles and birds really are the dinosaurs' living relatives.

Your professor has made this DNA class an exciting experience. The chief is going to be in a good mood when he sees your grade — perhaps he'll assign you an exciting new case.

BELIEVE IT OR NOT

The headline of the Goose Creek Gazette said it all:

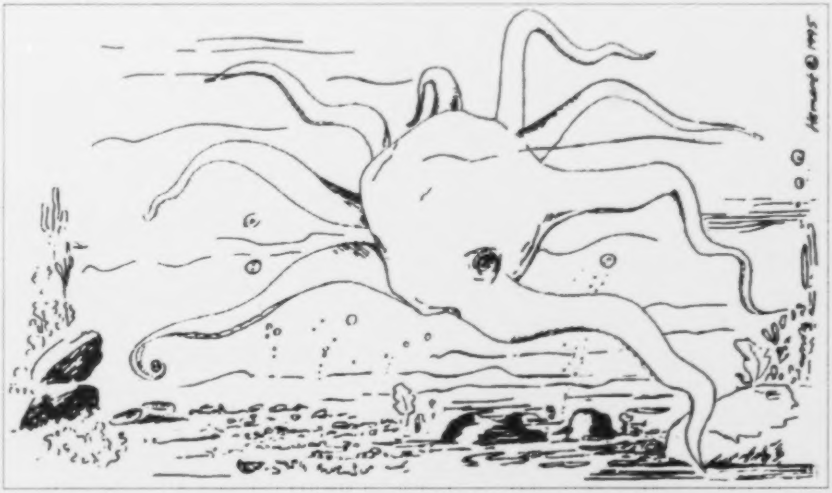
Priceless Pearls Pinched

Eight priceless pearls were stolen last night from the Goose Creek Museum, according to Goose Creek Chief of Police T.L. Jones. The robbery was discovered early this morning by the museum curator Harvey Smith. The police found no sign of forced entry and nothing else was taken. The pearls, which were kept in a 2,000 gallon aquarium and guarded by deadly barracudas, just "seemed to vanish," said Smith.

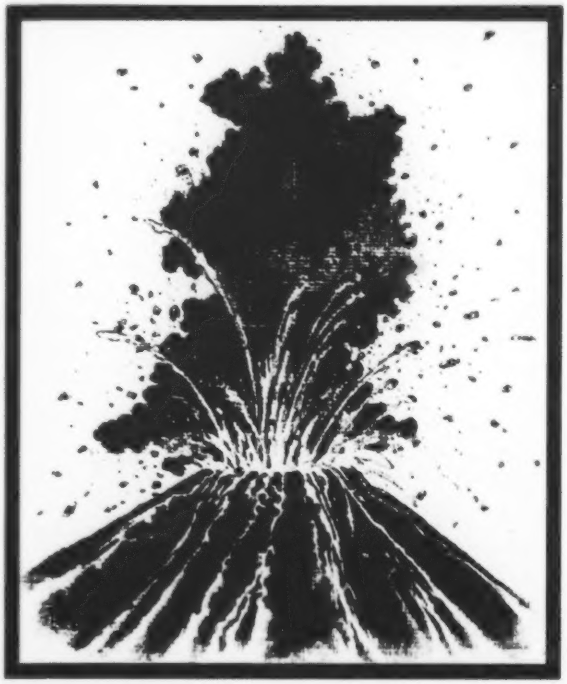
Jason had been the first to say in class that morning that it would be easy to solve the mystery of the missing pearls. Most of his fellow students disagreed, and even his teacher looked like she doubted that statement. But Jason felt confident that the case could be solved. He would need that confidence if he was to take a stab at it, because so far the police were completely baffled. News reporters had flocked to the sleepy little town of Goose Creek, and the missing pearls were the top feature on every newscast. The world was calling it the "criminal caper of the century." No one thought the thief could be caught except Jason.

Jason's confidence grew out of the skills he learned in science class. Throughout the school year, Jason's science teacher had told the class over and over again about the importance of the scientific method. She explained to them that scientists use the scientific method as a way to investigate problems. She would always go on to say that "even if you aren't a scientist, you can still benefit from thinking like one." Jason took this advice to heart by becoming more observant and asking more questions. He was always coming up with some possible answers that usually led to more questions.

That afternoon, after the last school bell rang, Jason headed straight to the Goose Creek Museum. There he observed the following: a floor covered by several large puddles of water; patches of strange, slimy goo on the floor and walls; and a step ladder leaning against the giant aquarium — the former home of Goose Creek's eight priceless pearls. Eight giant empty oyster shells were now at the bottom of the aquarium. Jason noted all the physical signs and went home to think about them.



WEIGHTY MATTERS



If you wanted to look for fossils, would you know where to begin? After all, scientists often search for days and even weeks to find potential fossil sites. Before beginning a search, it's important to know what kind of physical conditions — such as rock type — indicate the presence of fossils. Professional fossil hunters know that a complete understanding of the Earth's structure and how rocks are formed is crucial to finding just the right spot.

Think of the Earth's structure as being similar to a peach. Both are solid, round objects called ***spheres.*** The surface of the peach (its fuzzy skin) is like the crust of the Earth. Under the Earth's crust is the ***mantle***. It corresponds to a peach's yellow, fleshy middle layer. The pit at the center of the peach is similar to the Earth's ***core.***

Scientists don't know much about the Earth's core or mantle because they can't drill down far enough to examine them. They do know, however, that the core is very hot and is composed of molten (melted) materials. The mantle, which is mainly solid matter, also has pockets of hot, molten material. Scientists know much more about the Earth's crust since we can make direct observations of this layer.

Rocks and minerals make up the hard, solid part of the Earth's crust. Making direct observations of the crust can be difficult because it is usually covered with dirt, sand, water, and plants. The best way to observe the solid part of the crust is to examine the side of a hill that has been cut away for a road. Depending on the geologic conditions in your area, the rock you see will be one of three types: igneous, sedimentary, or metamorphic.

Igneous rock was the only type that existed during the early part of the Earth's history. It is formed from hot molten rock called ***magma*** found in the Earth's mantle. When the molten rock breaks through the Earth's crust, it is known as ***lava***. Lava is released when a volcano erupts. Any organic, or living, material in its path is burned, so you won't find any fossil remains in this type of rock. As the lava bursts out onto the Earth's crust, it produces different types of igneous rock depending on the conditions present.

If the lava cooled very quickly, a type of rock known as obsidian is often formed. Obsidian looks like black, shiny glass. When lots of air bubbles are trapped inside lava as it cools, an igneous rock called pumice is created. The trapped air bubbles make pumice so light it can float on water. When magma cools before it breaks through the Earth's crust, it forms a type of igneous rock known as granite. Granite is often used in the construction of stone buildings.

If you have ever studied an old stone building, you know that stones can become weathered. ***Weathering*** is caused when forces such as wind or water break rocks down into small fragments. Many of these tiny, weathered rock particles end up on the ocean floor. The pressure from all of the water pressing down on these fragments creates ***sedimentary*** rock. With the exception of fossils found in tar pits and amber, all fossils are found in sedimentary rock.

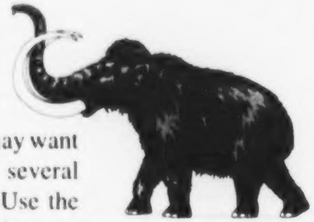
Sometimes fossils show up in a sedimentary rock known as shale. Shale is formed from layers of mud and rock fragments that settle to the bottom of a lake or sea. Limestone, another type of sedimentary rock, is formed when the shells of dead undersea animals become deposited on the ocean floor. Limestone cliffs often contain rich stores of fossil sea life. Coal is sedimentary rock formed when plants in swampy areas die and rot. Over millions of years, pressure placed on these plant remains forms coal. Coal sometimes contains fossils.

A third type of rock is known as ***metamorphic***. All metamorphic rocks were once igneous or sedimentary rock. They are created when igneous or sedimentary rocks on the Earth's crust are pushed back down into the mantle and exposed to intense heat and pressure. Marble is an example of metamorphic rock. When the sedimentary rock known as limestone is heated and pressurized, it turns into marble. Marble is used to make statues and buildings.

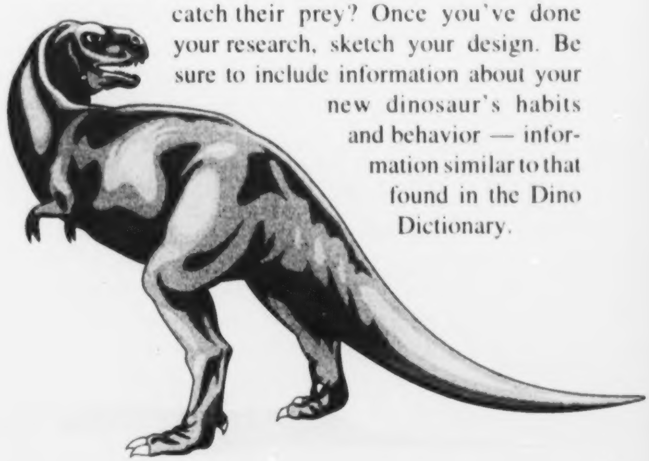
Fossils are rarely found in metamorphic rock because the heat and pressure usually destroys any fossil present in the original rock. So, scientists avoid igneous and metamorphic rocks when searching for fossils. They concentrate on areas where most of the rocks are sedimentary. Even then, it can take a long time to actually find a fossil. Is the effort worth it? It must be, considering all that we've learned about the Earth through the study of fossils. Thanks to fossils, for example, we know that periodically the Earth experiences widespread species extinctions, ices ages, and other dramatic environmental changes.

• HOMEWORK •

Design-A-Saurus



You can't change the past, but you can pretend to. Your homework assignment is to design your own dinosaur. You may want to combine features from several different known species. Use the Dino Dictionary and other resources to learn more about these famous creatures. Your observations about their body structure will help you understand what physical characteristics contributed to their protection or survival.



Does a vegetarian (plant eater) need a long neck in order to eat treetops? Do you think meat-eaters or carnivores need strong jaws and sharp claws in order to catch their prey? Once you've done your research, sketch your design. Be sure to include information about your new dinosaur's habits and behavior — information similar to that found in the Dino Dictionary.

IS 6

Think About It

What if you saw the following story in your local newspaper:

> *A one-of-a-kind animal has just been discovered in the Canadian Yukon. The creature was turned over to authorities, who have called in some of the most famous animal experts in the world. So far, none of the scientists have been able to identify the creature. For the moment, officials are calling it "One of Everything," but have nicknamed it Alfie. An amazing three meters tall, this lone male has only one eye, one ear, one leg, and one arm. As yet, officials have been unable to determine its feeding habits. Scientists hope to find out more about Alfie in the next few days. So far, no pictures have been released, but one official was quoted as saying "Alfie is as gentle as a kitten — he just looks mighty strange. We know everyone will love him when they get to know him."*

That's a story you'll probably never read, since there is no way that such an animal could survive on Earth. Organisms on this planet have to be able to find food, water, and shelter, so nature would not create a helpless species like Alfie. From cats and dogs to swordfish and whales, nature uses a body pattern in most land animals called ***bilateral symmetry.*** Any object which looks the same on both sides of an imaginary line has bilateral symmetry. Every animal with bilateral symmetry can be divided into a right and left side, which appear more or less the same. With this in mind, let's look at what makes Alfie helpless. We'll start with his legs. Two legs are important for maintaining balance as well as moving around. When humans lose a leg, or are born without one, we are able to get artificial limbs to help us walk and even run. Alfie would not be so lucky, and could only stumble or hop wherever he went. It's not likely that he could compete for food with animals who have two or four limbs.

If Alfie saw something he wanted to eat, he'd have a hard time telling how far away it was, since he has only one eye. One eye is great for getting an image of something and knowing it is there. However, we need two eyes for

stereoscopic vision — the ability to tell how far away something actually is. So, even if Alfie spotted something he could eat, he'd still be out of luck. With just one eye, he would lack the depth perception needed to catch his prey.

Now, that would be bad enough, but the newspaper also reported that Alfie has only one ear. That means that although he can hear things, without a second ear he can't locate where a sound is coming from. As you know, sound often alerts us to danger. Most creatures can use sound to locate something, even if their eyes are closed — but to do that you need two ears.

Finally, hands, paws, or claws are also important survival tools. These body parts make it possible to pick up or hold on to large objects, but most of all they help with eating. That's why animals have two of these things. When humans are missing a hand or arm, they can get an artificial one, but animals can't. Think how awful it would be for poor Alfie if he found some food and then couldn't grab it. So you see why it wouldn't be practical for nature to create an animal like Alfie?

What do you think would become of our imaginary friend, Alfie? He would probably thank his lucky stars that he was rescued, since he would need plenty of help getting along with only one-of-everything. Since he's such a gentle creature, he'd probably find more than enough new friends ready to lend him a helping hand. But don't expect to find Alfie anytime soon.

BRAINY BITS & BYTES

Life would be very boring if the only pattern found in nature was bilateral symmetry. It would also be mighty dangerous for all the creatures floating around in water or air. These animals have to be able to defend themselves from all directions. An animal species would disappear if it wasn't able to catch food and stay around long enough to eat it. Every species also has to live long enough to reproduce. That makes it important for many animals to be able to protect themselves from all sides.

Since nature is such a good designer, these animals have a different type of symmetry — one that does allow them to protect themselves in all directions. It's called ***radial symmetry.*** Here are some great examples: there are starfish with their five arms or rays; sea urchins that have spines all around them; and sea anemones with many tentacles.

Are all creatures perfectly symmetrical? Let's zoom in to see if they still look symmetrical when we get a good, close look at them. We'll start with humans. We have already said that humans have bilateral symmetry, meaning that they look the same on both sides when divided down the middle. Zoom in on a face, and it still looks symmetrical until you get about 0.5m away and study the features closely. At that point, you will notice that while both sides have half a nose, one eye, and half a mouth, there are some amazing differences. Take a look at your own face in a mirror. Maybe one eyebrow is different from the other, or maybe even the color of one of your eyes is different from the other. Is your mouth exactly the same on both sides? Lots of people have a mouth that tilts up on one side and not on the other. And of course, lots of people have dimples on one side of their face, but not on the other. Don't you think these little differences make us all more interesting to look at?

The differences don't stop with our facial features. Most of us have two legs and feet, but many people have one leg that is longer than the other. We usually think that our feet are identical until it is time to buy shoes. That's when the shoe salesman often informs you that the reason you're having a hard time finding a comfortable pair of shoes is that, like nearly everyone else, one foot is slightly longer or wider than the other.

Many marine creatures display the same curious differences. What looks symmetrical from a distance is actually asymmetrical up close. Crabs and lobsters are good examples. They have the same number and type of claws on both sides of their bodies, but when you measure them with a ruler, you find that one claw is longer than the other.

These differences are some of the most interesting and mysterious aspects of nature — mysteries that few of us even think about! It turns out that most things appear symmetric when we take the general view, but are actually asymmetric once we do a more detailed analysis. What a break for our brains! We quickly grasp what group something belongs to, but at the same time, after a little study, we can correctly distinguish between two of the same type object.

BELIEVE IT OR NOT

As he reviewed what he knew, Jason remembered a kindergarten field trip. His class had gone to see the pearls, and the tour guide had told them that just beyond the public's view there was a cage full of vicious barracudas. If any of the gems were disturbed, a motion detector would cause the barracudas' cage door to open. Anything or anybody attempting to steal the gems would be attacked immediately by these vicious flesh-eating fish.

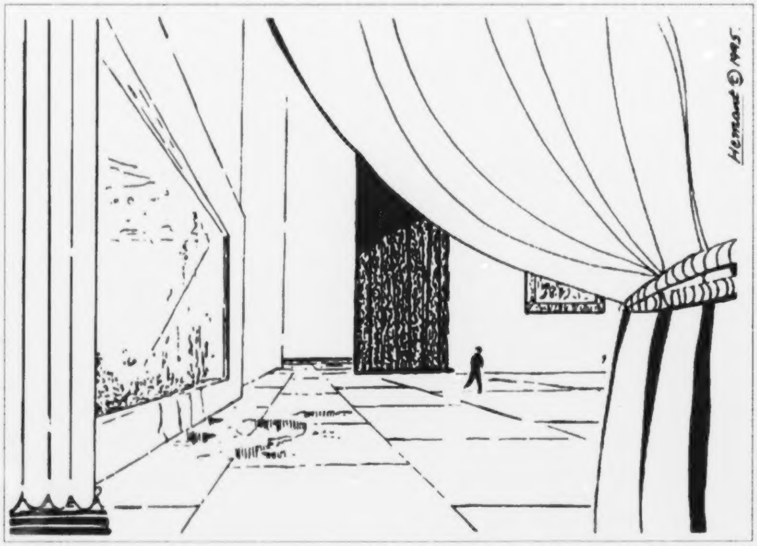
Incredibly enough, someone had been brave enough to challenge this defense system. If only the confused-looking barracudas swimming around in the aquarium could talk, Jason could solve this mystery. He knew he didn't have much to go on. The stepladder, puddles of water on the floor, and the strange slimy stuff on the walls and floor were all the clues he had. Would this be enough? Suddenly he had an idea.

Jason had already decided that the crime was an inside job. That part of the case had been easy to figure out because the museum's alarm had not gone off, nor were there any signs of forced entry. The pearl thief could only have been one of two people who were usually in the museum at night: Joe, the custodian, and Earl, the night watchman and part-time octopus trainer. But Joe had been out sick the previous night, so that meant the thief had to have been Earl. Besides, Earl had the tools...

And what kind of tools had Earl used to commit this crime? Jason hypothesized that Earl's first act had been to prop a stepladder up against the aquarium. Then, he had taken one of his highly trained octopuses from the Saltwater Sea Life exhibit and carried it over to the aquarium containing the pearls, slopping water and octopus slime on the floor and walls in the process. After tying a nylon around the body of the octopus, Earl had climbed up the ladder and lowered the octopus into the aquarium. The octopus had slowly unfurled its eight arms and, in a single motion, plucked the eight gems from their oyster shells. Jason realized that Earl must have hoisted the octopus out of the tank so quickly that the barracudas couldn't attack.

Now, if only Jason could get Earl to confess to the crime, the case could be wrapped up. He had an idea...

Jason spotted Earl, who was standing near the aquarium talking to a police investigator. He walked up to them and said to the policeman, "You know, only a radially symmetrical creature could have pulled off this caper."



BELIEVE IT OR NOT, *continued*

Earl blurted out, "But octopi are bilaterally symmetrical!"

"Who said anything about octopuses, Earl? Officer, arrest this man for the theft of the gems," said Jason.

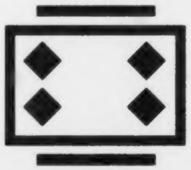
Later, after Earl had been carted off to jail, Jason explained everything to the investigators. He told them Earl was right — an octopus is primarily a bilaterally symmetrical animal. Its entire head can basically be divided into two planes. But they all had a good laugh when Jason went on to tell them that octopuses also exhibit radial symmetry since the eight tentacles extend radially from its mouth. Poor Earl, he had given the right answer, but said it at the wrong time!

funfact

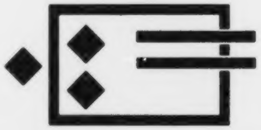
When something does not have symmetry, it is said to be asymmetric. Many interesting examples of asymmetry exist — including some from the animal world. Take the flounder, for example. Flounder eyes migrate to the top of their head and over to one side, so the flounder winds up with both eyes on the same side of its head!

SUPER ☆ CHALLENGE

See if you can create an asymmetrical design. When you are done, write a brief statement explaining whether you think symmetrical or asymmetrical patterns are easier to create. Be sure to mention which type you find more pleasing to the eye.



SYMMETRICAL
DESIGN



ASYMMETRICAL
DESIGN

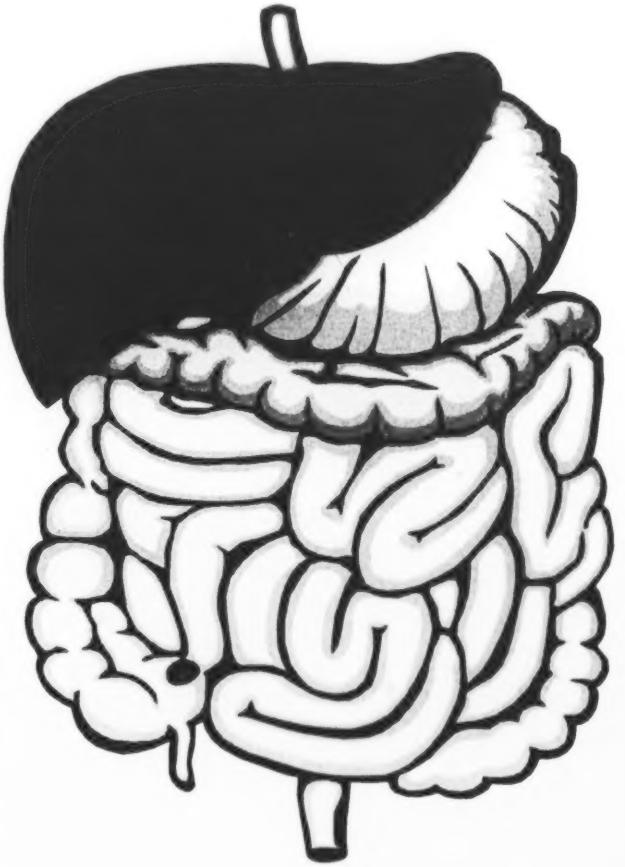
WEIGHTY MATTERS

The mouth is the opening used by an animal to take in food. The mouth works in cooperation with other body parts and certain chemical reactions to carry on the process we call ***digestion***. Most ***digestive systems*** are variations on the idea of a long tube. The food an organism needs is taken in, broken down by various chemicals, then absorbed so that the organism obtains its energy needs. Just how the digestive system for a particular animal is organized depends on many things.

Look for a match between what an animal eats and the kind of digestive system it has. ***Carnivores***, animals that eat meat, have short digestive systems. ***Herbivores***, animals that eat plants, have long digestive systems. Plant-eaters need a longer digestive system because plants are harder to digest than meat.

Most animals which have different head and tail regions (including earthworms, dogs, and humans) have digestive systems with two openings — a mouth and an anus. These animals are usually bilaterally symmetrical, too. Their digestive systems are often specialized, with different organs doing different jobs. Some organs cause physical changes in the food, while others cause chemical changes. Some do both jobs.

In the human mouth, for instance, the digestive process begins as food is broken down and ground up by the teeth. This results in a physical change in the food. The odor and/or taste of food causes the mouth to produce saliva, making it easier to swallow whatever we are eating.

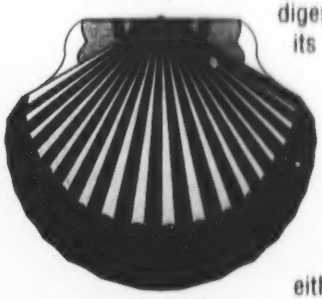


Most animal digestive systems (including humans) are also designed so that the animal doesn't have to spend all of its time eating. When there isn't a match between diet preference and digestive system design, however, serious problems arise. The ***panda***, for example, has the short digestive system normally found in a carnivore, but it only likes to eat bamboo plants. Since the panda's short digestive system can't digest bamboo plants very well, much of what it eats isn't processed by its body. So the panda has to spend most of its time (about 15 hours a day) eating in order to obtain enough nutrition and energy to live.

continued

WEIGHTY MATTERS, *continued*

Of course, there are plenty of animals with unique ways of digesting food. The ***starfish*** is a radially symmetric undersea animal that eats snails, clams, and oysters. To other animals, this might present a problem since snails, clams, and oysters can all completely retreat inside their shells. The starfish manages to get around this problem thanks to its unique digestive system. The starfish begins its attack by crawling on top of its prey (for example, a clam). The clam defends itself by closing its two shells together as tight as it can. But the starfish, which has several rows of small tube feet under its tentacles, counterattacks by attaching its feet to either side of the clam's shell. The starfish then pulls on the shell until the clam tires out and allows its shell to open just a little. At that point, the starfish's digestive system takes over.



The lower part of the starfish's stomach turns inside out, exiting through the starfish's mouth. It enters the clam through the small crack in its shell. Once inside the shell, the starfish's stomach releases digestive enzymes which dissolve the clam's soft tissue. Once the starfish's stomach has pulled in the digested material, the starfish's "feet" release the empty clam shell. Mission accomplished, the starfish is off to find another meal.

There are also animals that have digestive systems with only one opening. Included in this group are radially symmetrical sea creatures such as sea anemones, jellyfish, coral, and hydra. In these animals, food enters through a body opening and is digested. The waste products from digestion leave through this same opening, which serves as both mouth and anus.

In fact, the simplest animals are able to digest food even though they have no mouth opening or specialized organs. One example is a sea creature called a ***sponge***. Sponges live underwater attached to rocks in areas where there are many tiny living things floating about in the water. They catch their food as sea water flows through the small pores that cover their bodies. The tapeworm is another organism that can absorb food from its surroundings. In this case the surroundings are an animal's digestive system where it lives. So, simple or complex, radially or bilaterally symmetric, everything finds a way to eat.

JUST FOR FUN:
SALIVA TREATS

Here's a simple little demonstration that illustrates some of the physical and chemical aspects of digestion. Rinse your mouth out with water and then chew on an unsalted cracker for several minutes. Surprisingly, after you chew awhile, you will notice that the cracker tastes sweet. That's because you have allowed enough time for one of the chemicals (enzymes) in your saliva to digest the starch. Since we don't usually chew our food for five minutes, the digestion of starches is normally not completed in the mouth. Challenge your friends. See if they know how to make a cracker taste like a cookie.

• HOMEWORK •

Mirror Talk

Let's see if you can figure out which capital letters are symmetric and which are asymmetric.

A B C D E F G H I J K

L M N O P Q R S T U V

W X Y Z

Here's the rule. A letter is symmetric if half of it creates a mirror image. Some letters create mirror images when we divide them between the top and bottom. Others work if you use the left and right side as the dividing point.

Start with the letters that you think will create a mirror image using the top or bottom half. List them in a row on a sheet of notebook paper and place all the other letters on the next line. Now, hold the paper upside down in front of a mirror. Did you get them divided correctly? You should be able to read the symmetric letters but not the asymmetric ones.

Now, do the same thing using the left and right sides of each letter to decide if it's symmetric. Put the symmetric letters in a line down the side of your notebook paper and put the letters you think are asymmetric in another line down the page. Now, hold the sheet up to a mirror. The left-right symmetric letters should look the same while the other letters will appear backwards.

See if you can write one word from letters with top and bottom symmetry and another with left and right side symmetry. Use a mirror to check out your choices.

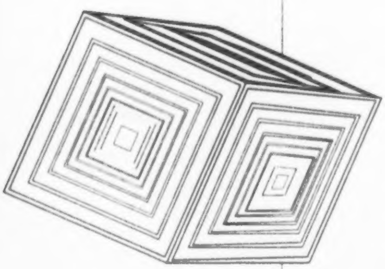
JUST FOR FUN

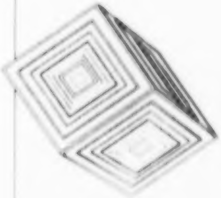
Words which are spelled the same in both directions are called palindromes. They are bilaterally symmetrical words. RADAR, NOON, and DEIFIED are three examples. Sometimes entire sentences are palidromes. Take a close look at . . . MADAM, IN EDEN, I'M ADAM . . . or . . . WAS IT A BAR OR A BAT I SAW?

Test yourself! How many palidromic words can you find in the following paragraph from Martin Garner's *Perplexing Puzzles and Tantalizing Teasers*?

"Look at the sun, over there behind the radar tower," said Hannah. "I think it looks much redder than it did at noon." "Wow! It sure does, Ma'am," exclaimed Otto, as he bent over to pat the head of a small pup with black markings over one eye."

• HOMEWORK •

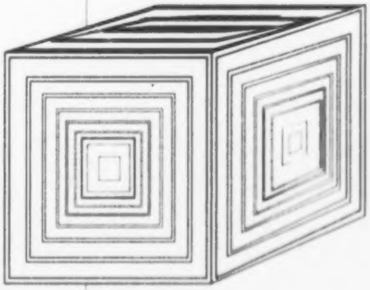




Growing Six-Sided Crystals

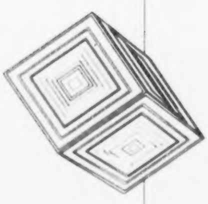
Crystals are some of the loveliest examples of symmetry, and they're fun and easy to grow. You can grow some using two common cooking ingredients: sugar and salt.

1. Carefully bring a cup of water to a boil.



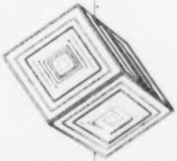
2. Add as much salt or sugar to the water as you can dissolve. (This should be about 1/4 of a cup of salt or 1 1/2 cups of sugar.)

3. Stir thoroughly until you have dissolved as much of the solid material as possible. Let the solution cool and pour it into a glass, jar, or plastic wide-mouth container.



4. Tie a piece of string or thread to a pencil. Let the pencil rest across the top of the container so that the thread falls down into the liquid. Do not cover the top.

5. Place the container in an area where it will not be disturbed. Examine daily for at least a week and write down your observations. Bring the crystal to school when your teacher requests that you do so.



Think About It

Many scholars think that modern science began around 1600 with Isaac Newton's study of the universe. Newton is often referred to as the father of modern science. Both his ideas about the universe and his approach to science were revolutionary. Unlike many great thinkers who had written about science before him, Newton refused to consider ideas that could not be demonstrated. He based all of his theories on observations of natural ***phenomena*** — a word which means observable facts or events. He described his method as "the method of analysis and synthesis," what the world has come to call "the scientific method."

Other scientists (like Galileo and Brahe) working at that time accepted his idea that observation and experimentation were the keys to science. Much of Newton's work benefited from the experiments of others. Newton thought of the universe as clock-like and he produced a set of laws that described its motion. For the first time scientists saw that . . .

Many things in the universe are regular and predictable.

Adopting the scientific method caused a lot of frustration. Much of the natural phenomena observed was not understood because at that time scientists did not grasp the concept of energy. But that topic and many other mysteries were unraveled during the next 100 years, as scientists around the world developed a systematic approach to science. Here are some of the things scientists do when they carry out a scientific investigation:

OBSERVE

ASK QUESTIONS

?

MAKE MORE OBSERVATIONS

FORM HYPOTHESES

CONDUCT EXPERIMENTS

RECORD AND STUDY DATA

FORM CONCLUSIONS

!

continued

Think About It, *continued*

Scientists often talk about having a plan or ***protocol*** for an experiment. When they use this term, they are setting up the scientific method. Using a protocol helps scientists remember how they worked. This is especially important when experiments are repeated in order to check results, or when work is being done in several different research centers at the same time.

The scientific method is a great way to figure something out, or solve a problem. But don't worry — using the scientific method does not mean throwing away your own ideas. Scientists often have a new theory or creative idea in mind when they set up an experiment. The scientific method simply helps us achieve a more complete understanding of what we are studying. It also helps to remind us that we should be willing to change our ideas when the data demands it. It is indeed the method of choice for science sleuths.

BELIEVE IT OR NOT

Jason couldn't believe all the attention he was receiving. When he awoke the morning after the museum incident, it almost seemed as if he had dreamed the whole thing up. His picture had appeared on the evening newscast, and now all his classmates had gathered at the school's front steps to greet their new celebrity. A newspaper reporter was at the scene, ready to take down every word he said.

Jason stood on the school steps, surrounded by his fellow students. They were staring at him in awe, amazed that one of their classmates had been able to solve the mystery of the missing pearls. The newspaper reporter stood waiting with her notepad and pencil ready. She was looking at Jason like he was some kind of hero — just because he had been able to figure out a mystery! Everyone was quiet, waiting to hear what he had to say.

"Uh, I just used the scientific method!" Jason admitted. "Even kids can figure out lots of things if they use the scientific method." Everybody looked surprised. Mutterings of agreement and approval drifted through the crowd.

"Exactly what is the scientific method, Jason?" the reporter asked. "And how did it help you solve your case?"

Jason's classmates were looking at him curiously, waiting for him to speak. "The scientific method is a process that begins with making observations. Observations lead to questions, which lead to more observations. After awhile you have enough information to form an hypothesis and test your ideas. Everybody learns about this in science class, but most people don't realize you can use the scientific method in everyday life. All kinds of people, like detectives, use the scientific method every day. It helps you solve problems."

Somebody in the crowd yelled, "Yeah, but don't you need fancy microscopes and other kinds of equipment to use the scientific method?"

"You don't have to have any equipment to use the scientific method," Jason said. "Take Aristotle, for example. He was a Greek philosopher and scientist who lived around 300 B.C., long before microscopes or any other scientific equipment had been invented. He had his own method for classifying plants and animals. Through observations and note-taking, he actually wrote a description of the development of a hen's egg that was completely accurate. Modern scientists are amazed that he could do all of that without a microscope. If you do hands-on science like we do at this school, you get pretty good at doing this kind of stuff."

"Well, Jason, you certainly have given us a lot of information." The reporter pulled her camera out of her bag. "How about a shot of you surrounded by all your classmates?"

All Jason's friends rushed to gather around him. A few of the tall boys hoisted him up on their shoulders. "Alright Jason," they cried. "Science is way cool!" Jason was really beginning to feel like a hero. "Smile for the camera," said the reporter. Jason grinned his biggest grin, all his classmates grinned, even the reporter grinned.

That afternoon, the Goose Creek Gazette ran a large picture of Jason on the front page. It showed him being hoisted into the air by his classmates. The headline above the picture said it all:

Riches Recovered, Earl Jailed, Jason Hailed

BRAINY BITS & BYTES

Scientists are "super sleuths" who study the mysteries of our universe. They are good investigators and enjoy hunting for clues, because finding clues often means solving a mystery. You can become a super sleuth, too, if you use the same techniques that scientists do when they perform an investigation.

Scientists like to explore the natural world. When they do an investigation they use both their imagination and strict test procedures. Even though they may appear to approach every problem differently, there is always some "method to their madness." The steps and details vary from problem to problem or scientist to scientist, but there is always a reason for what is done. Eventually, evidence is gathered, hypotheses are formed and tested, data is collected and analyzed, and conclusions are drawn. Together, these techniques are known as the ***scientific method***.

So, to become a super sleuth, you need to be curious. This is one of the most important traits of a good scientist; he or she looks at the world, sees interesting things and asks questions: why; how; what if? When you find a question you want to investigate, it's helpful to do more observations and gather all the clues you can find — just like a detective. Then you can form an hypothesis. An ***hypothesis*** is one possible answer to your question. So it is actually an "educated guess" or prediction about why something happens or how an event will turn out. It is called an educated guess, as opposed to a wild guess because you use clues that you've read or observed to form it.

To illustrate, let's pretend that your dog has had puppies. In fact, she had six! Of course, you plan to keep them all and take care of them yourself. But your mother is not thrilled with the expense of feeding all of these animals. She has told you that you'll have to start paying for their puppy food out of your allowance.

So you decide to accompany your mother to the grocery store and explore the dog food aisle. There are several brands of puppy food on the shelves. You find the two brands your mother suggested. One, an economical store brand called *Food Market's Best* has **"Super Low Price"** written in bold red letters across the bag. The other, a highly priced name brand called *Woofer's* has **"Puppies Thrive On It"** — their advertising slogan — on the bag. Now, which brand should you choose? Should you buy the well-known and possibly more nutritious national brand, or save your money and buy the less expensive store brand? Will it make a difference?

Your mom tells you that she has started feeding the puppies *Woofer's* because the puppies on their TV commercial really gobble it up. But when you check the labels you find that both brands have the same ingredients. So won't the puppies do as well eating either brand?

"Let's go about this more scientifically," you say. "We can use the scientific method to conduct an experiment. I'll ask the veterinarian how I can tell if the puppies who eat the store brand are as healthy as the puppies who eat *Woofers*. Once I have that information, I can develop my hypothesis."

"Whatever you say, dear," says your mother as she hurries off to see what's on sale at the meat counter. Later, you telephone your vet to discuss your problem. She tells you that she knows a puppy is healthy if it gains ten percent of its birth weight every month and has a shiny-looking coat.

After thinking about what hypothesis to use in setting up your experiment, you decide on ...

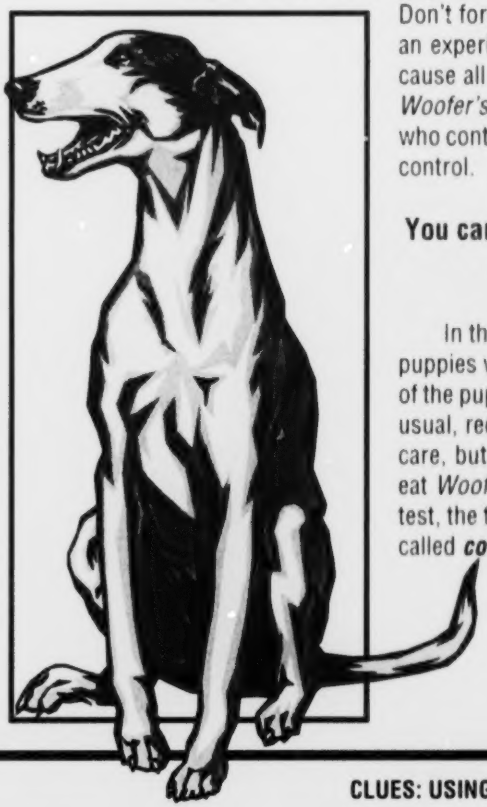
If the store brand of puppy food is as good for puppies as *Woofers*, then the puppies will all be healthy.

Notice that the words "if" and "then" were used. An hypothesis is often written this way because it emphasizes a cause (if...) and effect (then...) relationship.

A good hypothesis can be tested. The test is called an ***experiment***. The condition tested is known as the ***variable***.

A variable is any factor that can change in an experiment.

A successful experiment tests only one variable at a time, which is why you can scientifically compare only one new brand of puppy food with the brand the puppies are eating now. The reference to the variable should also be very specific. So let's look at our hypothesis again. "Will be healthy" is probably too general a phrase to use in an hypothesis. We need to write a new one that will make it obvious what variable we are testing.



If *Food Market's Best* is as healthy for puppies as *Woofer's* brand, then puppies who eat the *Food Market's Best* will gain as much weight as those who eat *Woofers*.

Okay, that makes things clearer. Now we know that we are going to measure the puppies' weight gain. Stating both of the brand names of the puppy food in the hypothesis will also avoid any confusion about the results.

So you have your hypothesis and you've bought one bag of *Food Market's Best* and one bag of *Woofer's* puppy food. This is sort of fun. Let's go ahead and set up your experiment. Don't forget that whenever you perform an experiment, you need a ***control***. Because all your puppies began life eating *Woofer's* brand, the group of puppies who continue eating *Woofer's* will be the control.

You can't perform an experiment without a control.

In this experiment, three of your six puppies will be the control group. All six of the puppies will go about their lives as usual, receiving the same kind of loving care, but three puppies will continue to eat *Woofer's* puppy food. In a scientific test, the things that remain the same are called ***constants***.

continued

Everything except the variable being tested must remain constant.

Fill the feeding bowls of the puppies in both your experimental and control groups three times a day. Weigh the puppies on the first day and then again every 10 days for a month. Compare the amount of weight gained by the puppies in each group. Was your hypothesis correct — do the puppies eating *Food Market's Best* gain as much weight as the ones that ate *Woofer's*? If your hypothesis is supported, you will probably want to ask other friends with new puppy litters to conduct the same experiment to see if they obtain the same results.

When a scientist finishes an experiment, he or she writes up a formal ***conclusion***. The conclusion reports the results of the experiment and states whether or not the hypothesis still seems reasonable. In this case, your experimental group of puppies was fed the same amount of *Food Market's Best* as the control group received of *Woofer's*. If their weight gain was equal, then your conclusion would state that "My puppies gained as much eating the *Food Market's Best* brand of puppy food as they did eating *Woofer's* brand. Based on the results of my experiment, I would recommend that this hypothesis be tested further."

Can you think of some problems you would like to solve using the scientific method? If you ask the right questions and are able to answer them, you will obtain lots of information that is helpful to you, your friends, or your parents. You may even discover answers to a problem that no one else has found. Learning and making discoveries are two things that make science very exciting.

Any time your experiment fails to support the idea stated in your hypothesis, your conclusion must state that your hypothesis was "rejected." If your experiment does support your hypothesis, then your conclusion should say that your hypothesis deserves further testing. In science, an hypothesis is considered worth testing as long as it is not rejected. As a result, hypotheses are tested over and over and over again. If the same results are reached each time, the hypothesis becomes a ***theory***. A theory is the best explanation scientists have to explain things they've observed.

Use the scientific method to find out which of the following hypotheses about your senses, if any, should be rejected.

If you rub an ice cube on your tongue, then your taste buds will not work as well.

If you brush your teeth, then you won't be able to taste sweetness for several minutes.

If vision helps your sense of balance, then you will sway when you stand with your eyes closed.

If you close one eye, then you can't catch a ball as well.

If you drink with both your eyes and nose held tightly closed, then Coke and 7UP will taste similar.

If you test all of these hypotheses, then you'll realize that your senses are more reliable if they are used together. By the way, are there any hypotheses in this group that should be rejected?

SLEUTH ALERT

READ ON!

If you've enjoyed what you've read in this handbook, don't stop learning. Below are some books we've selected just for you. Whether they're fact or fiction, these books give you more information about some of the material we've covered in the handbook. You should be able to find them at your local library or bookstore. If you have trouble locating one, ask your teacher to send us a message and we'll try to help track it down.

Mysteries in American Archeology by Elsa Marston — This author takes a look at some of America's unsolved archeological mysteries, from Mystery Hill in New Hampshire to Serpent Mound in Ohio. "The world is full of mysteries left by people of the past," the author states. Try exploring some of the exciting mysteries in this book, and learn a little about America's past at the same time.

The Trojan Horse by Warwick Hutton — If you were interested in the story of the Trojan Horse that we used in the handbook, you'll enjoy this book, which tells the whole story of the war between the Greeks and Trojans, and the suspense that led up to the trick of the Trojan Horse.

The Illustrated Dinosaur Dictionary by Helen Roney Sattler — Almost anything you could ever want to know about dinosaurs can be found in this book. With 175 drawings of dinosaurs, it will be fun to see what you're reading about! There is also a location reference of dinosaur discoveries throughout the world.

Dinosaur Dig by Kathryn Lasky — Six families set out to look for fossils in the Badlands of Montana. Their everyday struggles are described (climbing up and down slippery siltstone hills in 100-degree heat, patiently and carefully scraping at rocks in the hope of uncovering a dinosaur bone). Lots of photographs accompany the book, so you feel like you're on the dig with these families.

Dinosaur Dances by Jane Yolen — If you like dancing, poetry, great pictures, and dinosaurs, you're going to love ***Dinosaur Dances.*** All kinds of dinosaurs are pictured doing everything from disco to square dances, and each scene has a funny verse. This book is pure fun.

The Summer of the Bonepile Monster by Aileen Kilgore Henderson — This book may turn out to be one of your all-time favorites. It's the story of a boy named Hollis who goes with his sister to live with their great-grandparents. Hollis finds himself in the middle of an amazing mystery that involves fossil bones, creeping kudzu, a cemetery, a singing mouse, and a magical bridge. It's up to Hollis to solve this mystery before somebody gets hurt!

• HOMEWORK •

Solution or Solid

Here is a neat way to put the scientific method to work. Every household has lots of chemicals. As part of your science sleuth training, we want you to identify a few and study one of their characteristics. Look around and select five liquids like salad oil, dishwashing detergent or shampoo, bleach, window cleaner, vinegar, etc.

To do this experiment you will need a clean, plastic ice cube tray. Carefully pour at least five different substances into the various ice cube compartments. Be sure to keep them separate — you do not want any of these liquids to mix. As you pour in the various substances, draw a chart of the tray showing what product went where. Include the tradename of the product as well as any chemicals listed on the label. Write a hypothesis (prediction) stating what you think will happen to the liquids in the freezer. Ex.: If shampoo is put in the freezer, then . . . .

Place the ice cube tray in the freezer and leave it there for at least 10 hours. On the next day, examine the tray and indicate on your chart whether or not the substance in each compartment changed phase. In other words, did it become a solid? Don't forget to wash the tray very carefully with soap and water when you are finished with it. Somebody might need it to make some ice cubes!

Pick-A-Problem

Scientists are not the only ones who solve problems using the scientific method. Any time you gather facts about a situation and try to figure out what they mean is a good time to use this protocol. If you visit the doctor because you feel ill, he or she usually listens to your symptoms and then conducts some tests to gather more information. After the doctor has studied the data, he or she makes a diagnosis or draws a conclusion about what is wrong. Mechanics and repairmen use the same method.

For tonight's homework, pick a problem that has bothered you or someone in your family. Maybe it's a broken lamp or toy, or something that is not working right with your family's car. Identify the problem and then explain how you would use the scientific method to find a solution to the problem.

SUPER ☆ CHALLENGE

After you complete the Pick-A-Problem homework, draw a flowchart that diagrams your analysis. A flowchart is an illustration of the steps in a procedure.

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